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Power Equipment of the Deahl Building

SMALL PLANT FOR THE GENERATION OF HEAT, LIGHT AND POWER CONTAINS INTERESTING FEATURES; AUTOMATIC OPERATION OF EQUIPMENT ELIMINATES UNNECESSARY ATTENTION

THAT LIGHT, HEAT and power may be generated at a lower cost than they can be purchased, has again been emphasized by the installation of a modern isolated plant in the new 6-story Deahl Bldg., located at 220-222 West Ontario St., Chicago. While this building has just been erected, and the plant has been in operation only since the middle of February of the present year, the owners consider that if the old building directly next to the new structure could, with its equipment of 2 Scotch-marine boilers and a 16 by 36-in. Corliss engine in the worst of operating condition, meet the figures offered by the central station, a new plant of modern generating equipment would certainly bring the cost of production down to a figure no central station would attempt to mention.

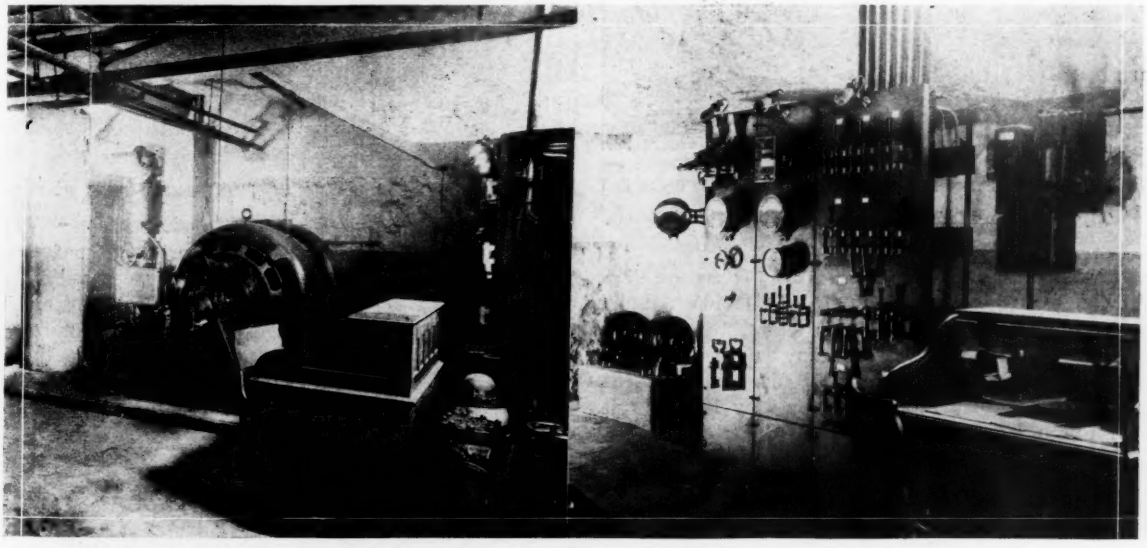


FIG. 1. VIEWS IN THE ENGINE ROOM SHOWING GENERATOR AND SWITCHBOARD

STEAM GENERATING EQUIPMENT

HAVING, AS just stated, but recently been completed, this building is not as yet fully occupied, the only tenant at the time of writing being a steam laundry, which obtains its electric light and power and steam for heating and laundry machinery from the plant below.

Steam is generated by 2 Kroeschell combination water-tube boilers, carrying an average pressure of about 90 lb., and provided with shaking grates burning No. 5 Illinois screenings.

The header carrying the steam to the engines, pumps, heating system and live steam lines for the laundry is made up, as shown in Fig. 2, of a series of tee fittings, an arrangement by which the various steam lines can be taken off from the third opening of the tee, resulting in a comparatively short and easily constructed header with a minimum of radiation losses. To reduce all possible trouble due to the collection of condensate, this header is drained by 3 bleeder lines connected to an Armstrong return trap.

As far as was deemed advisable for economical and safe operation, automatic regulating and controlling apparatus has been installed. Some of this is of standard

make, such as found on the market today, while some of the schemes employed have been worked out by the men responsible for the design and erection of the plant.

Attached to the boiler setting and within plain and constant sight of the firemen, is a Lawrence damper regulator, as shown in Fig. 3, together with a small panel carrying a Columbia recording steam gage, indicating steam gage and an indicating hydraulic gage used in connection with the damper regulator. By means of this regulator, even with a great variation of load, the steam pressure is maintained within 4 or 5 lb. of the desired value.

Heating System

After passing through a Watts reducing valve, reducing from boiler pressure to 1 lb. above atmosphere, the steam is carried to the radiators on the various floors of the building, the old section being supplied with steam at practically atmospheric pressure.

Returns from these 2 heating systems are led to a receiver, from which the condensate is pumped to a Moffat combination feed-water heater, purifier, oil ex-

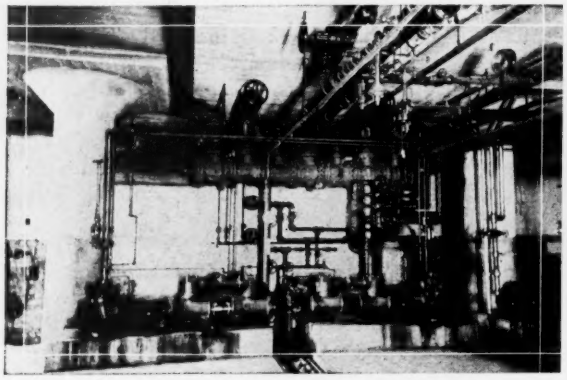


FIG. 2. PUMPING EQUIPMENT SHOWING HEATER-SUPPLY, BOILER-FEED AND HOUSE-SERVICE PUMPS

tractor and storage tank, located on the second floor. By means of a 6 by 4 by 8-in. M. T. Davidson duplex steam pump, water from the city mains, together with this condensate, is fed to the heater, where it is heated to an average temperature of 170 deg. F., and then pumped into the boilers by a 7½ by 5 by 10-in. duplex steam pump also of the Davidson make. The pump which conveys condensate from the receiver to the heater is under automatic control, being started and stopped by means of a float valve located in the receiver operating a pilot valve on the steam supply line.

To eliminate the necessity of continual running back and forth to observe the temperature and quantity of water contained in the heater, the line coming from the heater and supplying the boiler feed pump has attached to it directly above the pump an indicating thermometer and an altitude gage, which indicates the pressure, in feet, head of water above it, instead of pounds.

To economize space, all steam lines, except those for heating purposes, are carried up the elevator shaft and, to remove any condensate which may collect, these lines are provided at the bottom of the shaft with bleeders connected to return traps, so that the condensate may be returned to the receiver or, if desired, may be led to the sewer.

To insure a continuous supply of dry steam to the mangles, located on the first floor and nearly directly above the boilers, a novel scheme has been employed. Each of the 3 mangles is supplied with steam at boiler pressure through a 3-in. line and, to eliminate the use of return traps, these mangles are connected by 2-in. returns to a common return header, running directly into the boiler. As the steam condenses, it passes into the return header and, due to the boiler pressure plus that pressure created by a hydrostatic head of about 4 or 5 ft., it is easily fed to the boilers, resulting in a simplified system of piping and economy in use of steam.

Another ingenious device is the mode of controlling the 4½ by 3¾ by 4-in. Worthington duplex pump used to supply the building with water for domestic purposes. After the necessary adjustments have once been made, the operation of this is entirely automatic. As shown in Fig. 4, the steam supply line of this pump is equipped with a hydraulically operated pilot valve, connected to

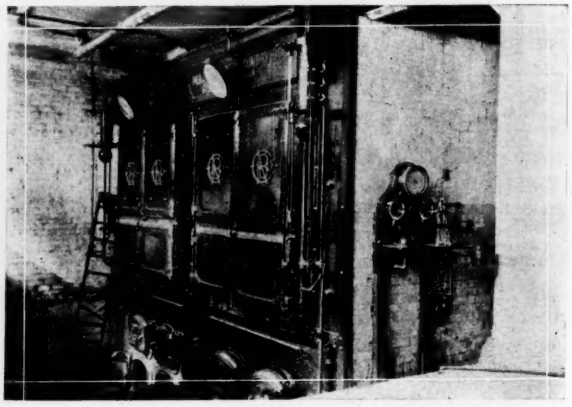


FIG. 3. KROESCHELL COMBINATION WATER-TUBE BOILERS

the discharge line by means of a short length of ½-in. pipe. With no water in the storage tank, located on the roof above, the steam valve is wide open, allowing the pump to operate and supply the tank with water. As soon, however, as the water rises in the tank, the hydrostatic pressure, due to the resulting increasing head of water, causes the steam valve to be gradually closed until, when the tank is nearly full and the pressure due to the static head a maximum, the steam valve is entirely closed and the pump stopped. With a slight lowering of the water in the tank, and resulting reduction in head, the valve is again opened and the pump slowly set in operation until the proper water level is restored.

Engine Room

This part of the plant contains the electrical generating, control and distribution equipment, consisting of a 150-hp. Ames automatic high-speed, noncondensing engine, directly connected to a 100-kw., 220-v., Crocker-Wheeler direct-current generator, a balancer set and a switchboard.

While the above-mentioned generator is of the 2-wire type, a 3-wire system of distribution is employed, and to care for such unbalancing of load, as is bound to

occur to a greater or less extent on such a system, a 125-v. compensator running at 1900 r.p.m., and with capacity to care for an unbalancing of 20 amp. has been installed.

This compensator is made up of 2 direct connected, direct-current machines, each having the above-mentioned rating. With a balanced load, no current flows through the neutral or middle line, causing but a small current to flow through the armature windings, which are connected in series, across the 2 outside lines. Both machines then act as motors. If, however, one side of the system carries a larger load than the other, there will be a greater voltage drop in the leads connected to it and, as a result, the voltage applied to the heavier load will be less than that applied to the other side or lighter load. Hence, the armature winding connected to the higher voltage side will act as a motor, causing the other armature to generate an electromotive force of such value as, added to that of the main generator, will cause the voltage applied to the heavier loaded side to be equal to that of the other side.

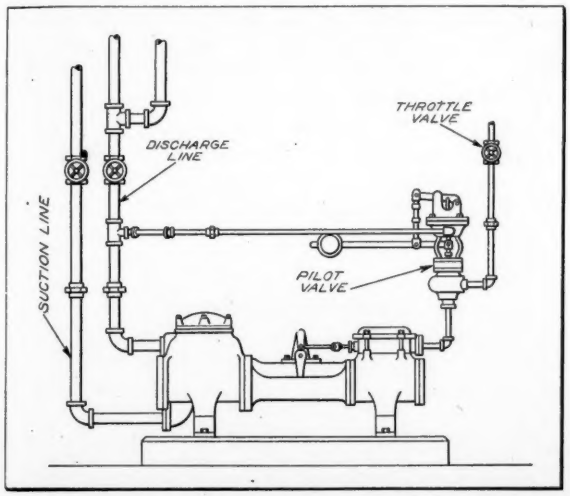


FIG. 4. HOUSE-SERVICE PUMP; ARRANGED FOR AUTOMATIC CONTROL; PRESSURE DUE TO HYDROSTATIC HEAD ON DISCHARGE LINE OPERATES PILOT VALVE ON STEAM SUPPLY LINE

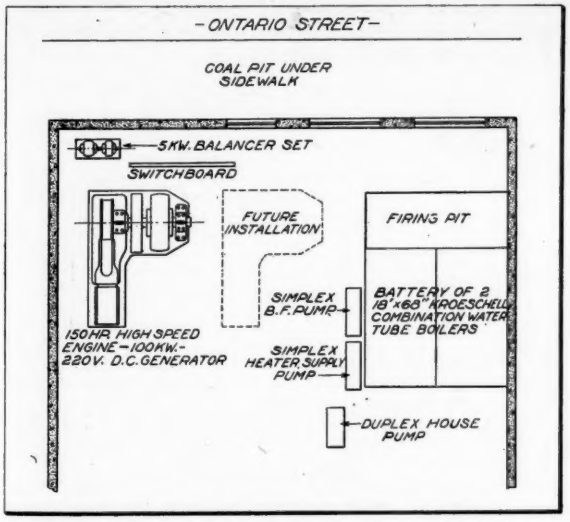


FIG. 5. GENERAL ARRANGEMENT OF PLANT, SHOWING RELATIVE LOCATION OF BOILERS, GENERATING UNITS, SWITCHBOARD AND BALANCER SET

To protect this compensator from an overload greater than 20 amp., a General Electric compensator relay has been mounted on the compensator panel of the switchboard, the function of which is automatically to trip the generator circuit breaker with an unbalancing of load, greater than 20 amp.

Buses from the generator panel connect to the adjoining distribution panel, which has mounted upon it the light and power distribution switches controlling the services to the various floors.

Electrical Load

All lines are carried in exposed iron conduit terminating in a distribution panel on each floor, each such panel being provided with a cut out and integrating watt-hour meter, so that the current for light and power used by each tenant may readily be measured and not only controlled from the board in the engine room but also at the entrance of the tenant's service.

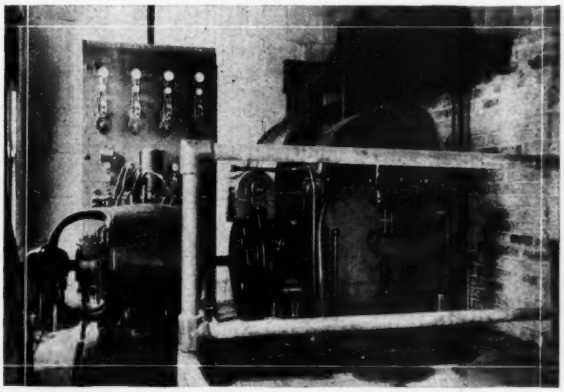


FIG. 6. HOISTING MACHINERY OF PASSENGER ELEVATOR

For the greater part, lighting is at present furnished by carbon filament and tungsten wire-drawn filament incandescent lamps, suspended from the various outlets by short flexible drop cords.

The 2 elevators, one passenger, the other freight, furnished by Kaestner & Hecht, of Chicago, are likewise driven by Crocker-Wheeler motors. Figure 6 illustrates the control panel, driving motor and hoisting machinery in the pent house above the passenger elevator shaft.

Designing and erection of this plant were under the direct and personal supervision of F. H. Schinneer and P. M. Geiseler respectively, the latter being at present in charge of the entire electrical and mechanical equipment of this building. And it is due to courtesies extended by these gentlemen that the preparation of this article has been possible.

A retarding element in the development of the use of superheated steam was the erroneous stand taken by the British Board of Trade that at the higher temperatures likely to be employed, the steam would be broken up into its constituent elements.

Scientific Boiler Feeding

DISCUSSION OF RESULTS OBTAINED BY USE OF FIXED AND VARIABLE LEVEL REGULATORS. BY E. W. NICK

TEN years ago, purchasers of automatic boiler feed water regulators demanded machines that would hold the water level constant and would at the same time feed exactly in proportion to evaporation. Under ordinary operating conditions, there are variations in the load on each boiler and these load changes are accompanied by changes in pressure which in turn affect the rate of evaporation. The only condition under which it is possible to hold a fixed water level and feed in proportion to evaporation simultaneously, is when the fires, draft, and load are absolutely constant, conditions which, however, do not exist in ordinary power plants.

Regulator manufacturers, in trying to supply the demand, found by actual experience that neither of these results was secured by intermittent feed, but, this was partially overcome by introducing a time lag so that the valve opening changed much slower than the water level.

Under favorable conditions, it was possible to hold the water level within an inch or 2 of the desired normal, but always with decrease in the boiler efficiency. One difficulty was the fact that a variable level was used as a reference in trying to secure a fixed level. The water level, as shown by the gage glass, is subject to violent fluctuations caused by firing and water feeding, so that the glass often indicates a false level. It is obvious that a regulator cannot maintain a fixed level in the boiler when it depends for its operation upon the gage glass level. Figure 1 shows what happens to steam output, water input, false level, true level, and steaming efficiency when an intermittent feed regulator is connected to the water column.

This difficulty can be overcome by taking a constant water level as a reference in order to maintain a fixed water level; that is, connect the regulator to an undisturbed point in the boiler water, which can be done by

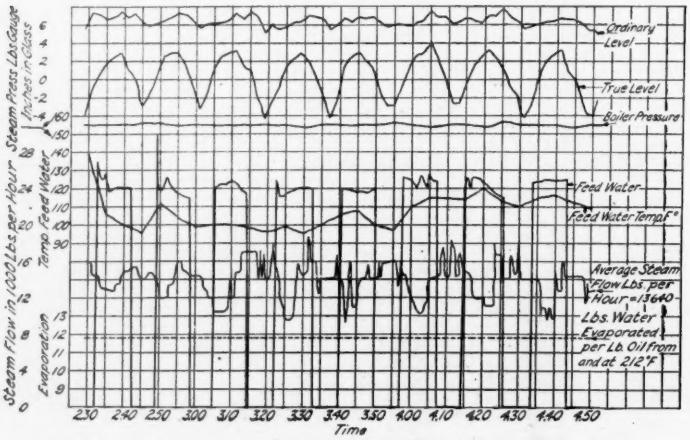


FIG. 1. RESULTS OF TESTS WITH INTERMITTENT FEED CONTROLLED BY THE WATER COLUMN LEVEL

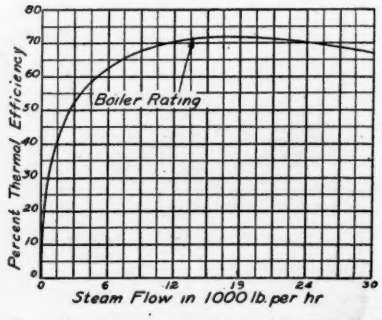


FIG. 3. RELATION OF BOILER EFFICIENCY TO LOAD

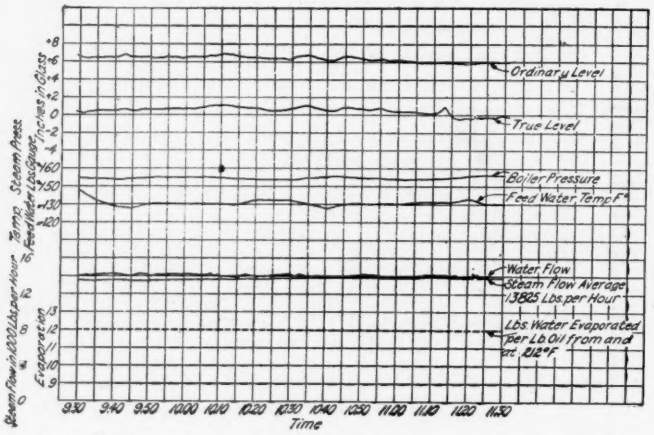


FIG. 2. RESULTS OF TESTS WITH COPES CONSTANT FEED REGULATOR

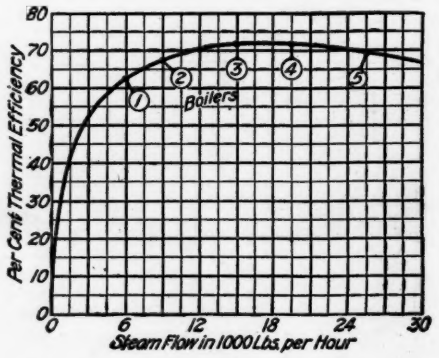


FIG. 4. FIVE BOILERS WORKING AT VARIOUS CAPACITIES

means of an independent water column, one end of which is connected to the steam space and the other end to the mud drum. The advantages of this method of connection can readily be seen by comparing Figs. 1 and 2. Figure 1 shows steam output drop every time the feed valve opens, producing an average steam flow of 13,640 lb. an hour, whereas in Fig. 2, with feed valve opening constant, the steam output remained constant, producing an average steam flow of 13,825 lb. an hour.

From the above it is evident that if the true water level in the boilers forming a battery is held constant, the output of steam will be uniform, depending on the demand, unless there is inefficient firing, due to clinker, holes in the fire, improper draft or opening of side doors, all of which are elements under control of the firemen, and if they exist, will readily be shown by an indicating steam flow meter.

Variable Level Regulators

Since it is impossible to change the fires quickly with every change in rate of boiler feeding, the water input should be continuous so as to utilize all the available heat energy from a constant fire. Furthermore, when the load changes, there should be a corresponding change in the rate of feeding and this change should be slow enough to allow a gradual and economical change in the fires.

In the past few years, power plant engineers have seen the numerous advantages to be obtained by lowering the water level to secure greater steaming capacity for peak and overloads, and raising it during subnormal and no load to save heat energy. Continuous feed and scientifically varied water level are therefore the most desirable features to be obtained by any method of feeding.

If the water were not in a state of violent ebullition, the gage glass and water column level would be dependable. But the contents of a boiler are really a mixture of steam and water, varying in specific volume with the load and steam pressure, so that the water level is subject to large secondary variations, and the water tender is incorrectly guided in regulating his feed valve.

It would seem logical to discard the use of the false level and to connect the regulator to a region of the boiler where the water is not subject to these secondary disturbances. But these fluctuations are in themselves an index of the boiler load and for highest efficiency and capacity, the rate of feed should take cognizance of both the load and volume of water within the boiler.

Let us consider what is going on in a boiler and from this determine just how it should be fed to give maximum capacity and efficiency. Suppose the temperature of the feed water is 180 deg. F., practically 200 deg. colder than the steam. To make a pound of steam, it is necessary first to heat the water 200 deg. F., thus adding 200 heat units, and then to evaporate it by adding 845 heat units. If the boiler has no storage space whatsoever, that is, if it would go dry were the feed cut off for only a short time, then it is necessary that the slightest change in load be accompanied by a corresponding change in the rate of introducing the feed water.

But an actual boiler holds a considerable volume of water, and when a demand for an additional supply of steam occurs, it is not necessary to increase the supply of feed immediately. Part of the water already within the boiler and at boiler temperature can be evaporated into steam, and this process may continue until the water has dropped to the lowest permissible level. Conversely, when the demand for steam falls off, it is not necessary that the amount of feed water be simultaneously decreased. On the other hand, the amount of water in the boiler can be increased so that the heat which would otherwise be lost is saved and utilized for heating up additional feed water.

Suppose, for example, that the load on a boiler suddenly increased by 100 per cent. If the rate of feeding water were increased at the same time by the same amount, then the furnace would have to generate 100 per cent more heat at once in order to keep up the steam pressure. This, of course, cannot be done, and therefore the steam pressure drops somewhat and the heat stored in the water is called upon to make steam. Obviously, the last thing to do under such circumstances is to inject a great volume of cold water into the boiler.

If the rate of feeding does not increase when the load increases, then the additional feed water need not be heated and the momentary load on the boiler is increased by only about 80 per cent since the amount of heat required to heat the feed is about 20 per cent of the total. If the feed water be cut off entirely when the load jumps 100 per cent, then the momentary overload amounts to only 60 per cent.

For high economy, all the boilers in a battery should be operated at the same load; that is, the load should be evenly distributed. If one boiler is carrying too small a share of the load, the others will be carrying too large a share, and as a result the battery will operate at low efficiency.

The relation of the efficiency to load is represented by the curve of Fig. 3. The efficiency of a boiler falls off gradually as the load is increased and rapidly as the load decreases below normal. It is therefore important that all the boilers of a battery be worked at uniformly high capacities.

Suppose that the 5 boilers of a battery are working at the 5 capacities indicated in the chart of Fig. 4. They would be delivering a total of 75,000 lb. of steam per hour, and the total battery efficiency would be 69 per cent. If the boilers are worked at a uniform high capacity, the conditions would be as shown in the curve of Fig. 5, where each of the 5 boilers is generating exactly 1/5 of the steam. The average battery efficiency is now 72 per cent, or a net gain of 3 per cent.

Unequal distribution of load between the boilers of a battery is caused by differences in condition of fire, of coal, grade of fireman or condition of the stoker, draft pressure, condition of setting as to leaks, condition of boiler surface as to soot and scale, position and condition of dampers, and to a great extent the rate of feed.

Feeding by hand cannot prevent the above difficulties. A water tender would be required for every boiler and even then a man cannot follow a fluctuating load, and at the same time make the proper allowance for the influence of load and steam pressure on the height of water observed in the gage glass. A steam flowmeter on each boiler to guide the fireman or stoker attendant has proved successful in regulating individual boiler loads, but it is found that hand feed causes wide and misleading fluctuations in steam flowmeter readings.

The steam delivery and flowmeter reading may be reduced from a heavy overload to practically zero load, by the sudden injection of a large volume of cold water. This is well illustrated by the curves of Fig. 6, showing simultaneous readings of feed water and steam output of a boiler forming one unit of a battery on which there was a uniform, constant load. The fireman had no knowledge of the fact that his work was being observed, and relied on the steam pressure gage and water column to guide him in regulating the feed water. Under such conditions the full advantages resulting from the use of steam flowmeters cannot be realized because the readings cannot be used as a guide to regulation.

The water tender and fireman are working at cross purposes. The fireman assumes that the pressure gage and steam-flow meter readings indicate the boiler and furnace load, and the rate at which heat is being absorbed from the furnace by the boiler, whereas the accu-

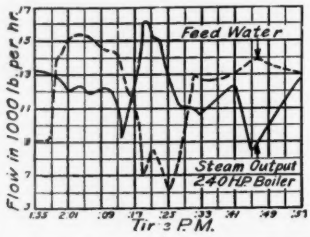


FIG. 6. EFFECT OF HAND REGULATION OF FEED WATER ON STEAM OUTPUT

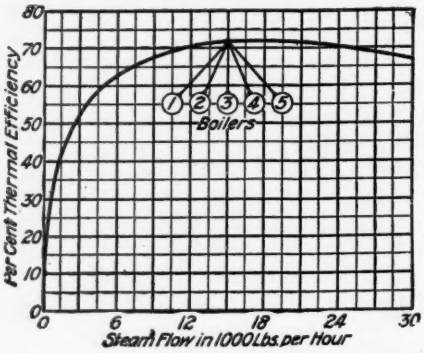


FIG. 5. FIVE BOILERS WORKING AT UNIFORM CAPACITIES

racy of the readings may be entirely destroyed and their utility nullified by improper feed. With hit and miss feeding, either by hand or by an automatic device, the fluctuations in feed may be so spasmodic as to render records of water flow entirely unintelligible and useless.

If every boiler is fed continuously while under load, and at the same time the water level is varied inversely with the load, this trouble disappears. All the boilers receive a share of the feed exactly in proportion to the furnace load. If the steam delivery of a boiler, as indicated by the flowmeter, is too low, it is corrected by speeding up the stoker, cleaning the fires, opening the dampers and regulating the air supply and then the increased heat generated causes increased steam delivery, which in turn causes the proper increase in feed supply.

Briefly, then, regulation of this kind will make the rate of feeding dependent entirely upon the furnace load, and as long as each furnace of a battery generates its share of the heat, each boiler of the battery will receive its share of the feed water and generate its share of the steam.

To meet these requirements, an automatic boiler feed regulator should have the following characteristics: On light loads, the water level should be high, so that the boiler stores a maximum amount of water and heat. Conversely, on heavy loads, the water level should drop, the heat of the furnace being used for evaporating water and not heating cold feed. To secure this fall in water level, the feed valve should close off the feed somewhat, when the load suddenly increases, thus increasing the heat available for evaporation, rather than heating of water. As the water level falls, however, due to evaporation, the regulator must increase the rate of feed until the amount being fed equals the amount being evaporated.

With a sudden decrease in load, the regulator must not decrease the feed until the water level has risen to

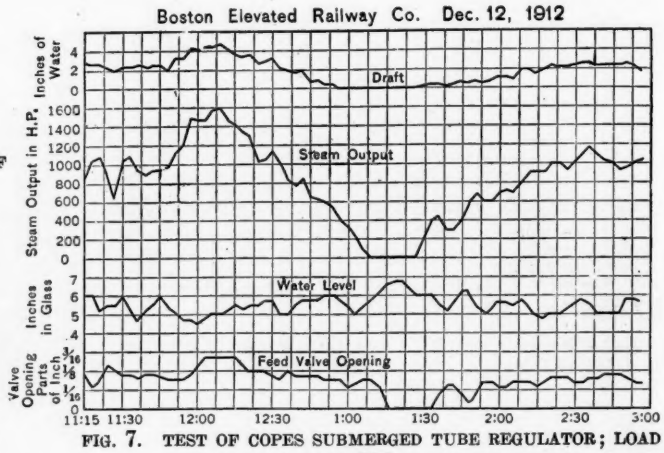


FIG. 7. TEST OF COPES SUBMERGED TUBE REGULATOR; LOAD VARIED FROM 0 TO 290 PER CENT RATING

the maximum and should even open up the feed valve to inject cold water very rapidly, so as to absorb the heat which would otherwise be uselessly generated by the furnace. After the water level has reached the maximum permissible height, the feed must be decreased or shut off entirely.

Finally, the regulator should be absolutely reliable and completely automatic so that when the load is removed from the boiler, the feed water will be completely shut off.

Actual Performance of Variable Level Regulators

That the foregoing is not impossible of accomplishment with an automatic device, is evident from Fig. 7. These readings were taken on a boiler whose load was intentionally varied from zero to 1600 hp., corresponding to almost 300 per cent rating. The maximum steam output is accompanied by the minimum water level, followed by a rising water level as the load decreased, and a maximum water level at the minimum output. The feed valve opening does not reach the maximum until about 10 min. after the first peak, showing clearly that

the water in the boiler is allowed to evaporate down to the minimum level before the feed valve opens up to compensate for the increased load.

Similarly, while the load fell to zero at 1:10, the feed valve did not close until about 10 min. later, and only after the water level had reached the maximum permissible level and cold water had been pumped into the boiler, so as to store and save heat.

From the foregoing it is obvious that a continuous feed regulator makes it possible to use a smaller feed line, smaller valves, and smaller boiler feed pumps for a given boiler horsepower output, or it permits forcing of the boilers without the usual increase in size of lines, fittings and pumps; because the control valve never closes unless the boiler is shut down, and as shown by Fig. 7, the valve maintains an intermediate position and is always partly open, so that water is fed to the boiler continuously. As a result, the valve is never called upon to open to its full extent, and is operating far below its maximum capacity. On new installations, the saving in the cost of fittings covers a large part of the cost of such a regulator. As boilers are driven at higher and higher loads by the use of mechanical draft and stokers, greater feed capacity is needed and this is amply provided by a system of regulation as herein described.

At one plant the 6-in. hand valves on 2365-hp. Stirling boilers are being replaced by continuous feed regulator valves which have a normal flow area of 3 in. and a maximum flow area of 5 in. Even with this reduction in valve size, the regulator control valve opening is 50 per cent of maximum at 190 per cent load, and 30 per cent of maximum opening at normal load. Three-inch continuous feed regulators are now being installed on the 2365-hp. Stirling boilers of the Solvay Process Co.

When the rate of feeding varies spasmodically, with consequent variations in the steam delivery, the temperature of superheat also varies through a wide range. The hot gases flowing over the superheater tubes transmit to them a practically constant amount of heat, so that if the steam delivery is suddenly decreased by injecting a large volume of cold water, there is a sudden rise in steam temperature, which may cause failure of fittings. With this system of feeding there are no sudden or spasmodic variations in feed, hence no spasmodic variations in steam delivery. Consequently undue fluctuations in steam temperature produced by the superheater will be prevented.

Furthermore, the steam is drier because the water is automatically maintained at a low level at the heaviest loads, when the danger of carrying over entrained water is greatest; hence, the superheater is not called upon to convert water into steam, higher superheat is obtained and deposits of scale in the tubes are eliminated.

With open feed heaters, efficiency is increased when the rate of feed is even and not subject to wide variations. If the demand for feed water is very large, due to excessive feed valve opening, the water level in the storage space falls very low and the float-operated make-up valve opens wide, introducing an excessive amount of cold make-up water, with a resulting decrease in temperature. On the other hand, if the feed valves are closed too far, the make-up water is shut off entirely, due to the high level of the water in the storage space, and steam may be wasted to the exhaust. Furthermore, if the feed valves remain closed very long, the water in the heater overflows to the sewer and wastes both the heat and the water.

Scientific boiler feeding is no longer a power plant luxury. It has now become a vital necessity of the modern boiler plant, and its advantages over the old methods of feeding can be briefly summarized thus: Higher overload capacity; more constant furnace conditions; less drop in pressure at overloads; storage of heat at low loads; even distribution of load between boilers; smooth rate of feed and no spasmodic opening and closing of the feed valve; smaller feed lines and valves; more even load on feed pump; more legible water meter and steam meter charts; dry steam since the water level cannot exceed a predetermined level and because the level is a minimum for greatest loads; higher superheat because water is not carried over into superheater tubes; more constant superheat because the rate of steam delivery is not affected by intermittent feeding; higher temperature of feedwater, which is drawn from the heater at a more even rate.

Central Lubricating System

DETAILS OF RESERVOIR, PIPE SIZES AND OPERATION. BY HARRY JOHNSTON

HAVING noted in Practical Engineer, some articles on single units for lubricating all engines, pumps, etc., from one main reservoir, with oil supply pipes that lead to the lubricators on different units, possibly some other engineers may be interested in one that I recently installed and have in successful operation.

Our yard foreman, with the friction saw, cut me a piece of 8-in., double strength iron pipe 18 in. long, and our machinist threaded it to a nicety on the lathe so that the caps screwed on 1½ in. and made tight joints; and they must be tight, too, if you wish to hold oil under high pressure, as it surely will sneak out of the fittings, if given the opportunity.

I tapped the steam header line at a point that gives me hydrostatic head of 8 ft. 6 in. on my reservoir, using ⅜-in. pipe, turned down sufficiently so that while it goes in through the top cap it extends to the bottom of the tank.

Oil supply line leading out of the tank is ½ in. to the first ¼-in. branch to the Atlas engine, then reduces to ⅜ in., as shown in sketch to tee. Then ¼ in. each way, one to air compressors, the other to my boiler feed pumps and to the vacuum pump on the heating system.

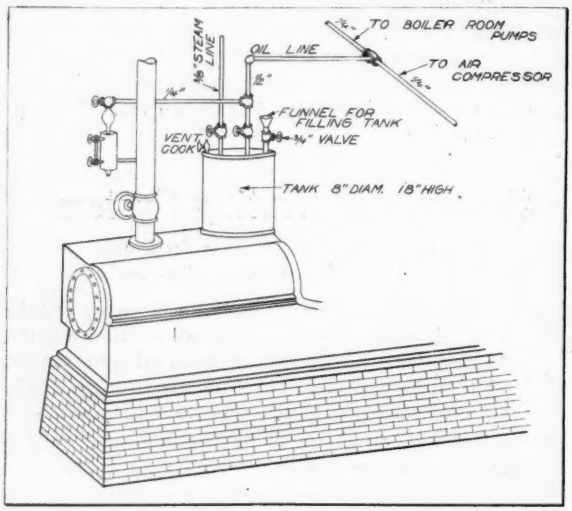
An air cock is used to vent the tank, while filling through ¾-in. gate valve, and a sight glass shows when oil disappears from sight that we still have 1 gal. left in the tank. A ¼-in. line from the bottom for drainage when refilling, completes the layout, except ¼-in. angle valves at each lubricator to shut off in case of any repairs.

You will note that oil is put in through the condensers on the lubricators, and the steam line to condensers is abandoned entirely, so the night watchman has instruction what valves to close in case of any accident to the system, and has no lubricators to fill or run empty during his shift.

Another advantage, I think, is this. In days gone by, while in charge of continuous operating plants, I have had some firemen, though not many, thank goodness, who were tricky enough to "pinch" the feed on their pump lubricators so as to run the filling over onto the next watch, and then "Let George do it." In the meantime, a groaning pump, also more coal used for the greater volume of steam consumed by the pumps.

A good grade of valve oil costs any concern some good "iron" dollars when purchased by the barrel, and I have always felt there was a happy medium between extravagant use, and on the other hand stinginess with it at the expense of the coal pile.

By careful study and thought, every engineer can figure out for his own particular conditions the right amount of valve oil to use from day to day, according



ARRANGEMENT OF CENTRAL LUBRICATING SYSTEM AND CONNECTIONS

to load condition in his plant. For instance, I will vary the quantity of valve oil fed into the steam cylinders of an air compressor different days, according to the volume of air being used in the shop by the hands. When the compressor is loafing along for hours at a time the steam cylinders do not require so much lubrication; also dirty boilers and moist steam are to be considered.

Let me say, in conclusion, that W. T. Meinzer is right when he says any good engineer, who takes pride in his plant, is glad to do away with "a mess of dirty coffee pots for filling, and old tomato cans for emptying lubricators."

THE USE OF a fluid composed essentially of glue and calcium chloride in solution, for laying coal dust, has been tested on a commercial scale at a Newcastle colliery with, it is affirmed, effective results. The liquid is placed in a specially designed 100-gal. tank, mounted on wheels, and is applied in the form of a spray, at a cost (which does not appear to be prohibitive), of about 50c. a yard every year. One application suffices for 3 months. Besides successfully accomplishing the primary purpose of laying dust, the liquid acts also as a preservative of timber.—Compressed Air Magazine.

Transmission Economy

DETERMINING THE FRICTION LOSSES OF SHAFTING, BELTS AND PULLEYS. BY N. G. NEAR

IN these days of power plant economy, don't neglect your transmission friction. It is possible to save much coal by taking good care of the old bearings, by installing new bearings of the ball or roller type, and by keeping the belts in good pulling trim.

A good way to determine the saving due to lessened transmission friction is to take an indicator diagram on the driving engine, with all machines running idle. That is, make the machines run, but do not allow the workmen to do any work in or on them while you are taking the diagram. The diagram thus taken will be a true "friction diagram." Its area represents the energy lost in carrying power from the engine to the work. In large factories and mills, the area of this diagram is often appalling, almost. It is so large that when the engine is running at "full load," the difference in area of diagram is scarcely noticeable. The friction load is often 70 per cent of the total power consumed.

Now, if we could reduce friction to zero, and if we could make the engine run with a mechanical efficiency of 100 per cent (both impossibilities), we should have an indicator diagram of zero area. This would be an "ideal" state of affairs. It cannot be reached, of course; but it can be approached ninety times in a hundred, and that is exactly what we should all strive to do; make your friction diagram area as small as possible.

Therefore, after taking your diagram, go over all your bearings carefully; clean them; rebabbit where necessary; remove all knocking, backlash, play; oil them with good oil or grease; and if the shaft is scored, true it up. If the bearing is an important one through which considerable power passes every day in the year, 10 or 24 hr. a day, it will probably pay you to change over to a ball bearing type. They are great power savers, and as made nowadays are proving themselves to be surprisingly durable.

Go over all belts, transmission chains and rope drives. Do not permit slip of any kind, for it must be remembered that each per cent of slip means a direct loss of one per cent of coal. Keep the belts in good, pliable running order. Release excessive tensions where it is evident that such tensions are creating unnecessarily high friction in the bearings. Do not sanction hard, stiff belts.

After doing all these things, and instructing the men to oil their machines, take another friction diagram. You will find a considerable reduction in area if your transmitting mediums were in bad order theretofore.

THE NUMBER of degrees in the arc of contact of a belt on a pulley can be arrived at by multiplying the difference between the diameters of the pulleys in inches by 4.75, dividing the product by the distance between the pulley centers in feet and subtracting the quotient from 180. Then to get the effective pull per inch of width of the belt, multiply the arc found above by 55, and divide the product by 180. This is for single belts; multiply by 1.6 for double belts and by 2 for triple belts.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Phase Displacement and Wattless Current

BRIEF DISCUSSION OF THEIR THEORY; WHERE FOUND AND HOW PRODUCED. BY V. E. JOHNSON

THE effect of field variation on synchronous machinery operating in parallel hinges so closely on the phenomena of "phase displacement" that a summary of the latter is, generally speaking, a logical introduction to any discussion of the former.

There is a tendency to assign mysterious meanings to technical words of very simple origin and use. The word "phase" as used electrically differs but little from the same word used in our everyday conversation, and a simple illustration may serve to explain what it means.

Imagine 2 pendulums, Fig. 1, A and B., swinging so: (1) left, (2) stop, (3) right, (4) stop, (1) left, etc.

We have 4 events, each of which is a part, a time, or a "phase" of the complete cycle. We may at will divide the oscillations of the pendulums into any number of times or phases, as for example in Fig. 2, we have (1) left (slow), (2) left (faster), (3) left (slow), (4) stop, (5) right (slow), (6) right (faster), (7) right (slower), (8) stop, (1) left (slow), etc.

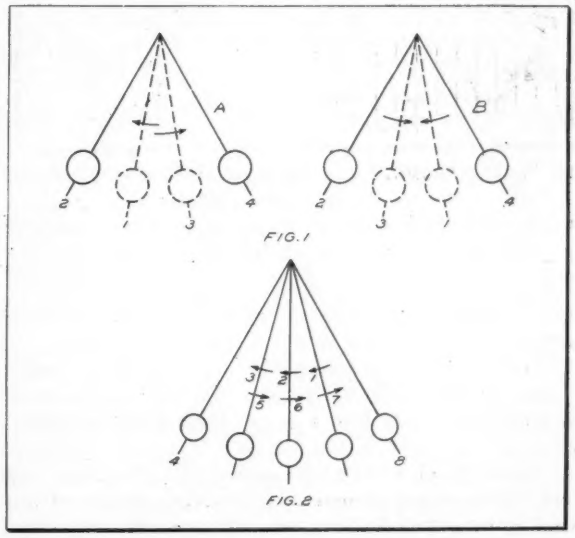
Every condition of motion or rest through which the pendulum passes during its swinging is a phase, or part, of its oscillation; that is, a phase of its cycle of events.

From this conception of "phase," the idea of displacement follows readily. If A and B swing simultaneously to and fro it is apparent that at every instant both pendulums are undergoing exactly the same changes in their motions; that is, they are passing through the same "phases" or events of their oscillations. It surely would not be stretching our English language greatly to express this condition by saying that the pendulums are "in phase."

Going a step further, assume that the pendulums are swinging at the same frequency—but that A is at all times 2 sec. ahead of B (that is, it reaches any point in its swing 2 sec. before B reaches a similar point in its swing), it follows from the previous paragraph that this condition can be logically expressed by saying that A and B have the same frequency, but are 2 sec. out of phase with reference to each other, or, in other words, have a phase displacement of 2 sec.

If, now, it takes 6 sec. for a complete swing to and fro—following the above reasoning—it would be possible to convey the same meaning by saying that A and B were swinging at the same frequency, but with a phase displacement of 1/3 (2/6) of a double swing or cycle. If we arbitrarily assume that the time duration of a cycle can be measured in degrees, and that it is equal to 360 of these (just as a yard equals 3 ft.), we can express ourselves in still a third way by saying that there is a phase displacement of ⅓ of 360 deg., or 120 deg. between A and B.

Similarly, if the pendulums were but 1 sec. apart, we could express this by saying that they had: a phase displacement of 1 sec.; a phase displacement of 1/6 cycle; a phase displacement of 60 deg., these 3 expressions meaning exactly the same.



FIGS. 1 AND 2. SIMPLE PENDULUMS USED TO EXPLAIN MEANING OF "PHASE" AND "PHASE DISPLACEMENT," AS APPLIED TO ELECTRICAL MACHINERY AND APPARATUS

It is not necessary to apply in detail this system of reasoning to arrive at the meaning of electrical phase displacement. Given 2 alternating electromotive forces with a frequency of 6 sec. per cycle (ordinarily expressed as 1/6 cycle per second), of which one reaches any given value 1 sec. sooner than the other reaches a corresponding value, we may logically express this by saying that the 2 e.m.f.'s have the same frequency, but have: a phase displacement of 1 sec.; a phase displacement of 1/6 cycle; a phase displacement of 60 deg. Of these, the latter expression is by far the most common.

Parenthetically, it may be remarked at this point that in alternating-current discussions it is, for reasons not germane to this article, the universal custom to divide a cycle into 360 parts of equal time duration, known as degrees.

Figure 3 shows 2 e.m.f.'s of approximately sine wave form, drawn with various degrees of phase displacement as indicated; and Fig. 4 shows the same e.m.f.'s drawn vectorially, the length of the vectors indicating the maximum value of the e.m.f.'s, while the angle between them indicates the displacement in degrees. This method has the advantage that it indicates to the eye much more readily than the curves of Fig. 3, the amount of displacement.

If in Fig. 4, ¼ in. = 25 v., A = 75 v., and B 100 v. They are displaced in one case 30 deg., or 1/12 of a cycle. Assuming a frequency of 60 cycles per second, one cycle equals 1/60 sec. We may then express the phase relation between A and B by saying that they have: a phase displacement of 1/12 of 1/60 sec., or 1/720 sec.; a phase displacement of 1/12 of a cycle; a phase displacement of 30 deg.

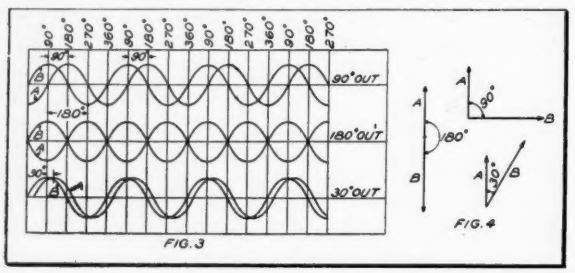


FIG. 3. ELECTROMOTIVE FORCE WAVES OF VARIOUS DEGREES OF PHASE DISPLACEMENT

FIG. 4. ELECTROMOTIVE FORCE WAVES OF VARIOUS DEGREES OF PHASE DISPLACEMENT DRAWN VECTORIALLY

It goes without saying that in a similar manner we may express the relation between 2 current waves or between a current and an e.m.f. wave.

In Fig. 5 are represented a current wave and a voltage wave, in various degrees of phase displacement as indicated; while Fig. 6 shows these same conditions vectorially.

We know, of course, that in dealing with direct current, the power delivered to a receiving circuit of any kind is expressed by the rule watts equal volts times amperes (W = EI). In dealing with alternating currents we must modify this somewhat—stating that the power at any instant is equal to the product of the volts times amperes at that instant.

In Fig. 7 we have 3 curves, E, I and W. E represents the voltage across the receiving apparatus, I represents the current flowing through it and W represents the power consumed in it; and is drawn by using for ordinates, or vertical distances, the product of the ordinates of the volt and ampere curves. For example: At the 90-deg. point, v. = 2; amp. = 3; and w. = 2 × 3 = 6.

It will be noted in this figure that the voltage and current lines lie partly above and partly below the zero line, this, of course, being a graphical expression of the fact that the current and voltage periodically reverse their polarity.

The power curve, however, is entirely above the zero line, as it is a graphical representation of the algebraic product of 2 quantities of similar sign. When 2 quantities are multiplied—one by the other—the product is a positive quantity if the multiplier and multiplicand have the same sign, either positive or negative; while the product is negative if multiplier and multiplicand have different signs, one positive, the other negative. The fact that the power remains positive regardless of the simultaneous reversal of voltage and current is somewhat analogous to the fact that reversing both field and armature of a direct-current motor does not reverse its direction of rotation. A further meaning conveyed by the unchanging sign of the power curve, is that the power is being delivered at all times in the same direction, and that during no part of the cycle does the load "feed back" into the generator.

Figure 8 shows the volt, watt and ampere curves of a circuit in which the volt and ampere curves have a phase displacement of 90 deg., which, as may be

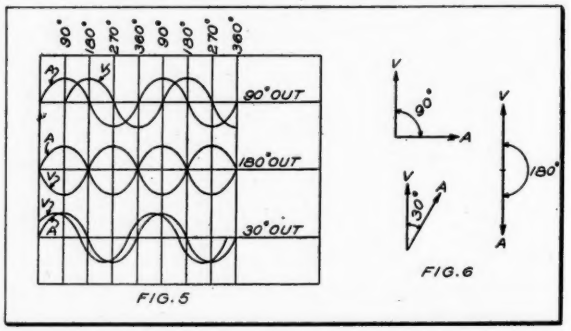


FIG. 5. VARIOUS DEGREES OF PHASE DISPLACEMENT BETWEEN CURRENT AND VOLTAGE WAVES

FIG. 6. SAME AS FIG. 5, DRAWN VECTORIALLY

readily seen, means that one is zero when the other is a maximum, and vice versa. It will be noted that as before the voltage and ampere curves are both above and below the zero line, exactly as in Fig. 7, but that in addition the power curve also is below the line during half of every cycle. This is determined by the sign rule, since half the time the voltage is negative when current is positive, or vice versa, and is analogous roughly to the effect of reversing the armature connections of a motor at times, leaving the field connections unchanged; or, more closely still, analogous to reversing both field and armature, but at different times.

Closer observation will show that the positive and negative loops of the power curve are equal. The significance of this is that during half of the cycle the receiver returns to the generator an amount of power exactly equal to that received from it in the other half, making the total delivered power zero.

Comparing generally Figs. 7 and 8, we find that in both we have the same values for volts and amperes, but that by introducing phase displacement of 90 deg., we have changed the power output from an effective value to zero.

In Fig. 9 is a third set of volt, ampere and watt curves, in which the phase displacement between the volts and ampere curves is 30 deg. Note that, as in Fig. 8, part of the power curve is below the zero line, but

that this negative part is not nearly so large as the positive loop. The significance of this is that although during part of the cycle the receiver is returning power to the generator, this returned wattage is not so great as that previously delivered to the receiver by the generator. To obtain the net generator output, we would subtract the negative part of the watt curve from the positive part.

When speaking of the value of alternating currents and electromotive forces, we do not mean maximum values, nor yet the average value, but the effective value, which in a sine curve equals 0.707 of maximum value.

In Figs. 7, 8 and 9, the effective values of voltage, E, and current, I, have been constant throughout, and the only variable elements have been the phase displacement and the power output. There is a definite relation between the watts output and this angle of displacement which may be expressed by saying that, "other things in a circuit being constant, the power consumed in it is proportional to the cosine of the angle of phase displacement between the current and voltage." That is, W = KEI (cosine angle of phase displacement), where K is a

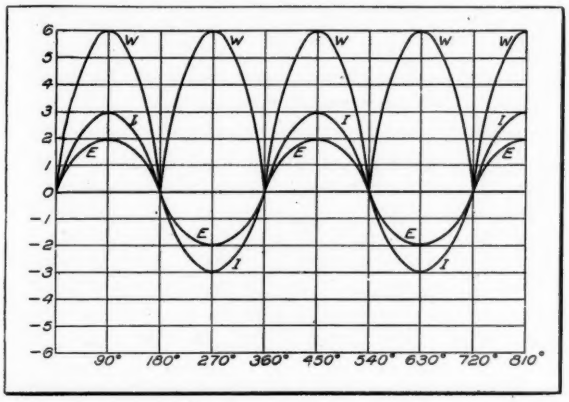


FIG. 7. VOLTAGE, CURRENT AND ENERGY CURVES

constant depending on whether we are dealing with single phase or polyphase circuits. No attempt will be made to prove the truth of this formula here—but the reader is referred to almost any text book on alternating currents.

In Fig. 7, then, W = EI cos L (L being a symbol used to designate the phase displacement angle), L = 0 deg., as the voltage and current are in phase.

From a table of trigonometric functions we find that cos of 0 deg. = 1. Hence, the watts will be equal to KEI × 1.

For Fig. 8, L, the phase displacement angle is 90 deg., and the cos 90 deg. is found to be 0. The watts will be KEI × 0, or = 0, as already explained.

For Fig. 9, where L is 30 deg., the cosine is found to be 0.866, hence the power will be KEI × 0.866. And for single phase current the value of K becomes 1, so that the power would be W = EI × 0.866.

Frequently it is assumed that the current may be considered as made up of 2 components (Fig. 10), one in phase with the voltage, one at right angles to it. The part in phase with the voltage will be I cos L, and its phase angle displacement will be 0 deg., hence the power due to this current would be as for Fig. 7, W = E × I cos L × 1, or = EI cos L. While the component at right angles to the voltage, I sin L, will have a phase displacement angle of 90 deg., hence, as for Fig. 8, the power due to this component will be W = E × I sin L × 0, or = 0. The component at 90 deg. to voltage is, therefore, called "wattless current." Of course, this splitting of the current into power and wattless components is theoretical, but it serves a practical purpose, and can easily be done by the rule given, that power component is equal to total current times cos L. If it were not for this formula, we would be unable to perform this theoretical division.

For example, in Fig. 9, we have, as previously determined, watts = EI × 0.86. Suppose that, E= 2 v. and I = 100 amp., we have then W = 2 × 100 × 0.86 = 172 w. Now, if we properly divide the 100 amp. into 2 parts—namely, 86 and 14 amp., we may obtain the same result, 172 w., by multiplying 2 by the component, 86. The other 14 amp. played no part in the production of watts, hence can be called wattless.

To make the fact clear that this division of current into a power component and a wattless component is only imaginary, and that there are by no means 2 kinds of current flowing through the wire, refer to Fig. 11.

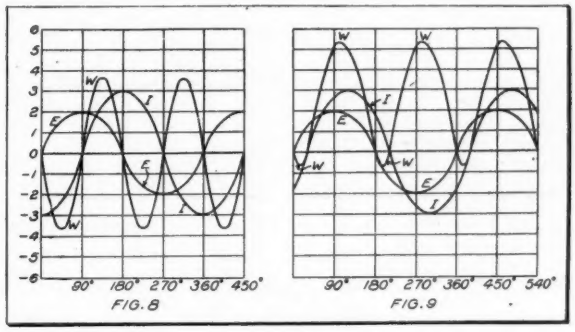


FIG. 8. EQUAL POSITIVE AND NEGATIVE POWER LOOPS RESULT IN ZERO OUTPUT

FIG. 9. 30-DEG. PHASE DISPLACEMENT BETWEEN VOLTAGE AND CURRENT CURVES

The horse at X is pulling on the rope with a force of 200 lb., necessary to keep the canal boat in motion. This 200 lb. may be divided into 2 parts, one of which forces the boat ahead against the friction of the water and canal bank, while the other merely presses the boat against the side of canal. This division is strictly logical, both mechanically and theoretically, yet it would be absurd to say that the horse was exerting 2 kinds of "pull" on the rope. As in electricity, the component of the current which does not produce power, is called wattless, so in this case the power exerted in pulling the boat against the shore might, by analogy, be called "motionless."

In Fig. 8, W = EI cos L = 0. We would naturally conclude that, if we divided our current into a power and a wattless component, the former would be zero, and the latter 100 amp., for 2 × 0 = 0. In other words, in this case all the current is wattless. This would, in Fig. 11, correspond to a condition in which the horse pulled in the direction indicated by the dotted line, in which case, the entire 200 lb. pull might well be called motionless.

In Fig. 7, watts = EI cos L = EI = 200. In this case, our power component would be 100 amp., while the wattless component was zero. If, in Fig. 11, the horse could walk directly in front of the boat, the 200 lb. would all be expended in producing motion; there would be no pull against the canal bank, and no "motionless" pull.

Having briefly covered the topic of wattless current and phase displacement, in general terms and without reference to where found nor how produced, we may properly take up that question by citing an incident recently experienced in a central station. Two alternating-current turbo generators were arranged and connected for parallel operation. The operators found that, when machine No. 2 was synchronized and in parallel with machine No. 1 and no adjustments made to No. 2 other than cutting out the resistance of its field rheostat and thereby increasing the excitation current to, say, 25 amp., No. 2 machine's ammeters indicated a load while its wattmeters indicated zero. The question which arose was whether or not this current could be termed wattless current, since the line current in No. 1 was reduced by the amount of amperes load shown on the ammeter of No. 2, and what the result would be if, in-

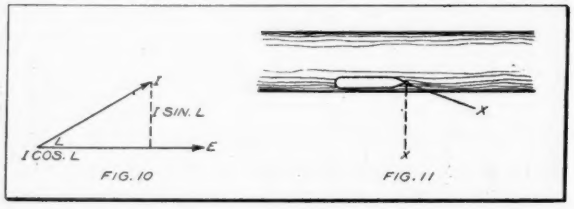


FIG. 10. VECTOR DIAGRAM SHOWING I COMPOSED OF 2 COMPONENTS, I SIN L AND I COS L

FIG. 11. PULL ON CANAL BOAT AGAINST SHORE ANALOGOUS TO WATTLESS CURRENT

stead of increasing the field current of No. 2 from 75 amp. (the amount required to bring its voltage up to that of No. 2) to 100 amp., it had been reduced to 50 amp.

From our previous discussion we find that, if wattmeters read zero, EI cos L must equal zero, and the power component of the current equal zero. This leaves the entire current as the wattless component. In general, we may say that in any alternating-current circuit in which the metering devices show 0 w., the entire current output must be wattless, for were the power component other than zero, the wattmeters would indicate.

Before proceeding to explain the electrical principles which cause a generator to deliver wattless current, let us consider the second question.

If the field current of No. 2 were reduced from normal to 50 amp., it would take current from No. 1 and cause an increase of No. 1's ammeter readings. The tabulation below shows the changes which would take place, the values for amperes being taken at random, as no data on this point has been furnished.

Any further increase of field current causes a still greater increase of current in both No. 1 and No. 2.

Similarly decreasing field current below normal causes an increase of current.

A synchronous machine can run only in step with those with which it is interconnected. Varying the field must produce a change in the electromotive force generated, but, if there is sufficient generator capacity to maintain constant bus voltage in spite of reasonable field variation in one generator, this additional electromotive force causes a current to flow between the various generators in such a way as to reduce or increase the voltage of the varying generator to normal. That is, if the field is increased above normal, the generator delivers current to the buses; and this current is of such phase relation with the voltage induced by the revolving field that it lowers the generated e.m.f. to the value of the bus voltage. On the other hand, if the field be reduced, the generator will deliver to the buses a current of such phase relation to the voltage generated by the revolving field, that it raises the generated e.m.f. to the value of the bus voltage. This effect comes under the head of field distortion and demagnetization and cannot be discussed at this time.

An induction motor has no field supplied to it externally, but must create a field for itself by making use of a portion of the main current, this magnetizing component of the current being wattless, so that, if we have a large number of induction motors running, the wattless

FIG. 12. CURRENT VARIATION WITH NO. 1. FIELD NORMALLY EXCITED

	Amp. No.2 field	Amp.Arm. No.1 Mach.	Amp.Arm. No.2 Mach.	Kw. No.1 Mach.	Kw. No.2 Mach.	
	25	2000	1000	1000	0	No. 1 amperes decreasing
	50	1500	500	1000	0	
Normal	75	1000	0	1000	0	
	100	500	500	1000	0	
	105	450	550	1000	0	
	125	550	650	1000	0	No. 1 amperes increasing
	150	900	1000	1000	0	

component of the delivered generator current may be quite large. This is apparently the case in the power station referred to.

By exciting the fields of a generator (or synchronous motor either for that matter) above normal, the circulating current referred to above is of the proper phase relation to supply this wattless current used for magnetizing induction motors.

Let us discuss the tabulation of current variation in the armatures.

When No. 2 has a field excitation of 105 amp., No. 1 has the minimum current, namely, 450 amp. Increasing or decreasing excitation of No. 2 increases this, and as 1000 kw. is the output at all times, it is apparent that this must represent the point where the wattless component is the nearest zero; in fact, we may assume that it is zero. At this point, No. 2 is supplying 550 amp. of wattless current, making a total of 1000 amp., all of which is delivered to the external circuit, No. 1 having no wattless current as just explained. Bearing in mind, then, that 450 amp. is the power component of the current, and that the external circuit requires 550 amp. magnetizing (wattless) current, let us consider the 100 amp. field point.

Here No. 1 is delivering 500 amp., of which 50 are wattless, the other 500 wattless amp. being supplied by No. 2.

At 75 amp. field current, No. 1 is carrying 1000 amp., 450 of power component, and 550 of wattless current. Number 2 is supplying no current whatever.

At 50 amp. field, No. 1 machine is carrying 1500 amp., of which 450 are, as before, the power component, and 1050 the wattless part. Of these 1050 amp., the external circuit takes 550, while the other 500 amp. circulate around No. 2 machine, raising its voltage to that of the bus, as previously outlined.

At 25 amp. field, No. 1 machine carries 2000 amp., divided as follows: 450 power component, 550 wattless component external circuit, 1000 wattless component circulating around No. 2 machine.

Going now to the other extreme, note condition at 125 amp. excitation. Number 1 generator is carrying 550 amp., of which 100 are wattless, the other generator, No. 2, is supplying 550 wattless amp. to the external circuit and is causing 100 amp. to circulate around No. 1 machine, these serving to reduce No. 2's voltage to that of the bus.

At 150 amp., No. 1 generator is delivering 900 amp., of which 450 are wattless. Number 2 machine is supplying 550 amp. to the external circuit, and is, in addition, circulating 450 amp. through the coils of No. 1 machine.

A Quick Operation

By Thos. G. Thurston

WHILE employed in a large substation, I witnessed what I considered the most brilliant bit of operating I ever saw. Current was supplied to the station at 9000 v., 3-phase, 25 cycles and was distributed at 4000 v., 3-phase, 60 cycles. The equipment consisted of 2 500-kw. motor generators or frequency changers, made up of 3-phase, 9000-v., 25-cycle motors direct-connected to 3-phase, 4150-v., 60-cycle generators.

Each motor received its current from a separate bus, which in turn was supplied by a separate line so that in case of trouble on one line or machine the other would not be affected.

Each machine had a 125-v. compound-wound interpole exciter mounted on the end of the shaft. A Tirrill regulator maintained constant bus voltage, while contact-making voltmeters maintained constant voltage at the feeder ends.

A synchronous motor must keep in step with the driving generator and alternating current generators running in parallel must be in phase. Paralleling 2 machines that are combination synchronous motor and alternating-current generator presents a different proposition to that of paralleling 2 engine-driven alternators. With the 2 motors driven from the same generator, it is obviously impossible to vary the speed of the incoming machine to bring it in phase with the running machine and with a given relation existing between the motors and the driving generator there is another fixed relation between the driven generators. To parallel the 2 machines, there must be the proper relation of the motors to the driving generator in order to parallel the 2 generators. In order to obtain this relation, it is necessary to do what operators term "slipping poles." This consists of opening the motor switch long enough for the synchronism indicator to make one complete revolution or, in other words, to allow the motor to slip back one pair of poles with relation to the driving generator, the switch being closed again at the moment of synchronism. This may have to be repeated as many as 4 times in some cases in order to bring the generator of the incoming machine in phase with the generator of the running machine. Due to the rapidly changing phase relation, the operation is rather ticklish for anybody but a thoroughly experienced operator for, if the switch is not closed at the proper instant, the motor is caught out of phase and chances are that the line will open or the machine will be badly damaged.

The accompanying sketch shows the connections of the 2 machines. At the time referred to, No. 1 was carrying the load, but the exciting current was supplied by the exciter on No. 2, which was also running, but without being connected to the generating system. The machines had been run this way on account of some tests being made. It was decided to cut out No. 1 and place the load on No. 2. On testing for synchronism, No. 2 was found to be out of phase, so it was necessary to slip poles to bring it in phase. One of the assistants was doing the operating. The chief operator cautioned him to be careful about cutting in again at the right moment when slipping poles and not miss it, for if he

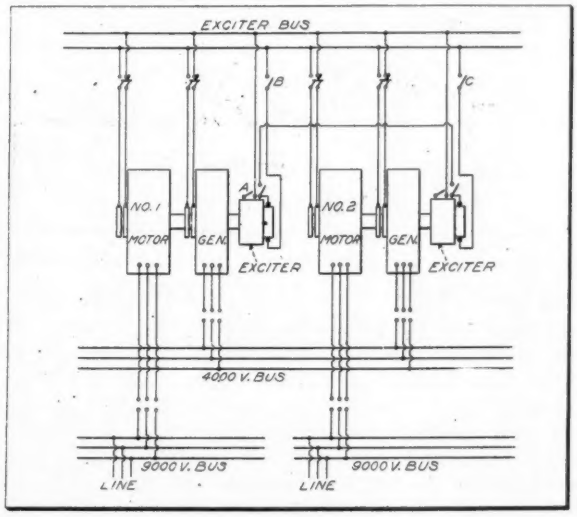


DIAGRAM OF CONNECTIONS BETWEEN FREQUENCY CHANGERS

opened the line or failed to close the switch, the exciting current being supplied by the exciter on this machine, he would lose the exciting current for the other machine and drop the whole load.

This is just what happened. The operator was a little late in closing the switch, caught the motor too much out of phase and opened the line.

Everybody was dumfounded for a moment, then with a bound the chief reached the switchboard and swung the field rheostat for No. 1 exciter into the full boost position, then made a dive back to No. 1 exciter and closed the positive switch A, located on the exciter frame. He then came back to the board and noted by the pilot light on No. 1 exciter panel that the voltage was building up rapidly and about normal, so he swung the rheostat back to about its normal running position, brought the negative switch B for No. 1 exciter up to where it could be easily closed, opened the negative switch C on No. 2 exciter until it began to arc across the contact points, then closed the negative switch B, of No. 1 exciter and pulled out the switch on No. 2.

The whole operation took such a short time that there was no indication of the trouble on the feeder recording voltmeters. The Tirrill regulator and contact-making voltmeters managed to keep the feeder voltage up until the other exciter was cut in and brought things back to normal.

Vector Conventions

CORRECT DIAGRAMMATIC REPRESENTATIONS OF ALTERNATING ELECTROMOTIVE FORCES AND CURRENTS

MANY alternating-current problems may be easily explained by vector diagrams, but there are several points in the use of vectors which are liable to be confusing. As ordinarily used, the vector represents the time-phase position and the magnitude of the maximum value of the alternating wave. Figure 1 shows 2 methods of representing an alternating wave. The wave may be plotted out on a time axis, in which

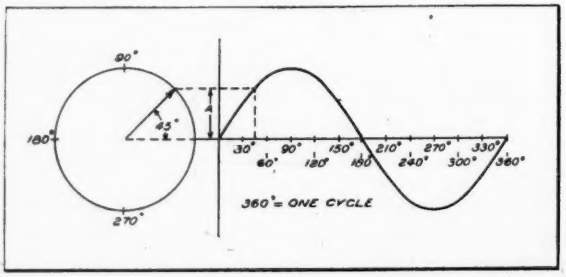


FIG. 1. METHODS OF REPRESENTING AN ALTERNATING WAVE

case the amplitude of the wave is the maximum value, and instantaneous values are ordinates to the curve at the particular instants considered. Another way of plotting the wave is by a vector whose length is proportional to the maximum of the wave and which is supposed to rotate counter-clockwise at such a constant speed that it makes one complete revolution in the time required for the wave to complete one cycle. The instantaneous values of the wave are always equal to the projection of the vector at the given instant on a vertical line. Thus it is shown in Fig. 1 that the ordinate of the curve at 45 deg. is equal, by construction, to the

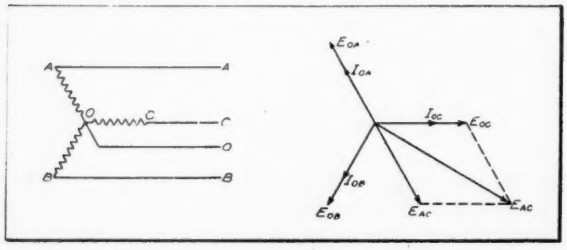


FIG. 3. STAR OR Y CONNECTION AND VECTOR DIAGRAM

projection of the vector, a. In the vector diagram, difference of time-phase is represented by an angle between 2 vectors. In the wave figure it is represented by the distance on the axis between the zero points of the waves. It will be seen from the above that a vector figure represents *maximum* values. Since sine waves are assumed, it is possible to represent *effective* values to a different scale because they are equal to maximum values divided by a constant, $\sqrt{2}$. Instantaneous values are not shown directly in a vector figure, but must be obtained by taking projections.

A point that gives some difficulty is the selection of positive directions. Any selection will do as long as it is consistently adhere to. Thus, it is convenient to consider the counter-clockwise direction around a delta, and the direction out from the neutral point of a "Y" as positive. Confusion can be avoided by following a simple convention. Draw a diagram of the circuit and letter all intersections. It is helpful to arrange these diagrams to correspond to the shape of the vector figure. When a vector is drawn and lettered, use 2 subscripts

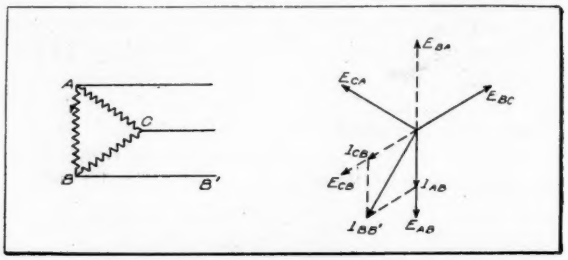


FIG. 2. DELTA CONNECTION AND ACCOMPANYING VECTOR DIAGRAM

denoting the points between which the current flows or voltage exists. Thus in Fig. 2, E_{AB} represents the difference of potential between A and B, A being the higher. E_{BA} represents the difference of potential between B and A which is equal and opposite to E_{AB}. In other words, $E_{AB} = -E_{BA}$. The same is true of currents. If the current in a line is desired, say BB′, add I_{AB} and I_{CB}, since both these currents feed into B and $I_{BB'}$, feeds out. If the currents are in phase with the voltages, the vector $I_{BB'}$, the sum of I_{AB} and I_{CB}, Fig. 2, will represent the current in BB′.

Figure 3 shows a star generator. If voltage E_{AC} is desired, add E_{AO} and E_{OC}. If the current in the neutral of a balanced star is desired, $I_{O'O} = I_{OB} + I_{OC} + I_{OA}$.

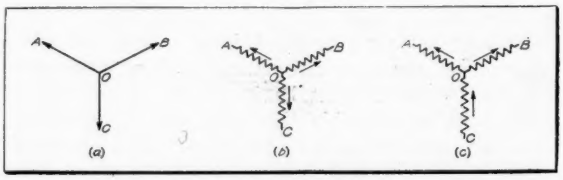


FIG. 4. VECTOR DIAGRAM OF CURRENTS (A), AND IMPROPER (B), AND PROPER (C) METHODS OF SHOWING INSTANTANEOUS CURRENTS IN A STAR CONNECTION

Using vector addition, this gives zero as the current in the neutral, if the currents in the phases are equal and at the same power-factor.

Care must be taken not to confuse vectors with instantaneous currents or voltages in the windings. In Fig. 4, (a) represents by vectors the currents in a star, but at no instant is the current flowing as in (b) for the current flowing in from C to O at a given instant flows out from O to B and O to A. That is, for *instantaneous* currents, Kirchoff's law, that the algebraic sum of all currents flowing to a point is zero, holds true.—The Electric Journal.

Useful Compounds for Power Plants

By F. B. Hays

CASES often occur in the operation of a power plant where the engineer is seriously handicapped for the lack of knowledge of some compound that will stop a serious leak or help repair a bad breakdown.

The following formulas represent a number of compounds that are adapted to power plant work, and which will be found useful in many emergencies.

Anti Freezing Solutions

1. Water 72 parts, calcium chloride 28 parts, by weight.

2. Water 69 parts, calcium chloride 10 parts, chloride of aluminum 20 parts, chloride of magnesia 1 part, by weight.

Boiler Compounds

1. Sodium chloride 12 parts, sodium hydroxide 2½ parts, tannic acid ⅛ part, potassium hydroxide ½ part, by weight.

2. Liquor made by boiling oak bark in water.

Brazing Compounds

1. For general purposes. Flux:—1 part borax and 2 parts boric acid dissolved in boiling water. Spelter:—copper 24 parts, zinc 8 parts, tin 8 parts.

2. For cast iron. Flux and spelter combined:—4 parts boric acid, potassium chlorate 1 part, iron carbonate ¾ part, 2 parts granulated tin, 2 parts granulated zinc, 4 parts granulated copper. Crush the whole in a mortar to as fine a powder as possible.

Cements

1. Acid and heat proof cement:—quicklime and linseed oil.

2. Cements for marble, glass, etc.:—sodium silicate mixed into a paste with either whiting or Portland cement.

3. To fill holes in castings:—thick paste of sodium silicate and dioxide of manganese.

4. To fill holes in woodwork:—thick solution of sawdust and rosin dissolved in hot glue.

5. To fasten iron in stone or concrete:—thick paste of glycerin and litharge.

6. To mend broken castings:—sodium silicate and iron filings; or sal ammoniac 2 parts, sulphur 1 part, iron filings 16 parts, pulverized and mixed with water at time of using.

Insulating Compounds

1. Electric:—2 parts pitch, 2 parts burnt gypsum.

2. Heat:—Sodium silicate, asbestos, sawdust.

Paints

1. Outdoor ironwork:—Boil sulphur in turpentine and apply solution while hot. Color, black.

2. Black for machinery:—mix by heating 3 oz. asphaltum, 4 qt. boiled oil, 8 oz. burned umber. Thin with turpentine while cooling.

3. For pipes and boilers:—lampblack and linseed oil, or asphaltum varnish.

4. Fireproof, black:—asbestos 98 parts, black oxide of manganese 98 parts, black carbon 1 part, boiled linseed oil 32 parts by weight. Thin with turpentine.

5. Fireproof, red:—asbestos 98 parts, Venetian red 98 parts, linseed oil 32 parts. Thin with turpentine.

6. Fireproof, white:—asbestos 98, zinc white 98, zinc sulphate 24, refined linseed oil 17, turpentine 2. Thin with turpentine. The asbestos used should be free from organic fibers and finely powdered.

7. Wood preservative:—crude oil diluted with gasoline, or whitewash to which has been added water glass.

Welding Compositions

1. For general use:—30 parts borax, 4 parts sal ammoniac, 4 parts potassium cyanide. Dissolve in hot water, then evaporate the water.

2. Copper:—31 parts boracic acid, 89 parts sodium phosphate.

3. Cast steel:—pulverized white marble; or borax 2 parts, iron filings 2 parts, sal ammoniac 1 part.

Soldering Compounds

1. Aluminum. Flux:—80 parts stearic acid, 10 parts zinc chloride, 10 parts chloride of tin.
Solder:—80 parts tin, 20 parts zinc.

2. German silver. Flux:—hydrochloric acid.
Solder:—19 parts copper, 27 parts zinc, 4 parts nickel.

3. General use. Flux:—hydrochloric acid.
Solder:—2 parts tin, 1 part lead.

Power Plant Lubricating Efficiency

IT is estimated that more than 50 per cent of the total horsepower produced in all power plants is consumed in overcoming friction, and a very considerable proportion of this power is lost through unnecessary friction, faulty lubrication and unsuitable lubricants.

From all outward appearances, it would seem that when cylinders, valves and bearings show oil upon the working surfaces, the plant was getting good lubrication, but if the proper oil is not being used on the moving parts or is not properly applied, there is a slow, steady wear which may not be noticeable, but which in the course of several years' time makes it necessary to reconstruct and take up the looseness of the working parts. Although the lubricant may be in evidence at all times, and while the frictional temperature of the bearings may not at any time be at a point to cause alarm, still, if the necessary film of oil between the moving parts is not maintained, undue wear will slowly but surely take place.

Selecting an Oil

By far the greatest single factor in putting a power plant upon an efficient lubricating basis is the selection of a proper lubricant. The days of selecting an oil by the old laboratory tests are or should be past. A number of years ago when lubricating oils were practically all made from Pennsylvania crudes, such labora-

tory tests as gravity, flash, fire, viscosity, and cold test had at least some value as a means of comparing one oil with another for the same purpose. However, as the production of petroleum spread over a number of states and as new crudes having different chemical and physical characteristics were introduced, this comparative value was lost except for oils produced from the same crudes.

The gravity of an oil indicates its weight at 60 deg. F. as compared with that of an equal volume of distilled water at the same temperature. To the well-informed oil man this test has some value in that it indicates to him the source of the crude from which the oil is made. For example, if the oil has a high gravity, it indicates that the crude from which it was made probably came from some of the Northern fields; an intermediate gravity in general would indicate a Southwestern crude. If the expert is entirely familiar with the characteristics and lubricating properties of oils made from these different crudes, this test might be of some value, but this knowledge is possessed by very few.

The fact is, that gravity in itself gives absolutely no indication as to the suitability of an oil, and, except as an indication of the crude from which the oil is made, is never given any consideration by the oil expert in selecting an oil for any particular purpose.

The difference in the gravity of different crudes is due to their different chemical composition. This, however, is a technical question which few oil men thoroughly understand, and which is outside of the scope of this article. It is interesting to note in this connection, however, that Archbutt & Deely, among the best authorities on the subject of lubricants, state that the crudes having the chemical composition indicated by the formula C_nH_{2n-4}, which are low gravity crudes, give the lowest co-efficient of friction as well as the greatest durability. According to these authors and according to the eminent investigators, Drs. Mabery and Matthews, this oil proved equal to sperm in reducing friction and superior to castor oil and to blended cylinder oils in durability. This is not due to their low gravity, nor do all low gravity crudes have these characteristics, but the crude having this chemical composition does have a low gravity.

The flash point of an oil is the temperature at which the oil upon being slowly heated gives off sufficient vapor to form over its surface a mixture with the air which will ignite when a small flame is introduced. This temperature will vary considerably with different instruments and with the different methods of making the test. An oil designated as having a flash of 320 might readily be found upon testing under different conditions to have a flash of 350, due to these variable elements. So far as the lubricating value of an oil is concerned, flash point is of no importance, if it is sufficiently above the working temperature to prevent too great evaporation of the oil. As the ordinary working temperature of a bearing is from 100 to 175 deg. F., a flash point above 300 deg. F. or thereabout would be high enough to meet all ordinary conditions. The fire point, usually 50 to 75 deg. above the flash point, is the temperature at which oil gives off sufficient vapor to burn continuously. Obviously this also has no bearing on the lubricating qualities of an oil.

The cold test indicates the lowest temperature at which the oil will flow. Just what cold test an oil should have is determined by the temperature conditions to which the oil is subjected. There are certain conditions under which an oil of a zero cold test is necessary and desirable; there are other conditions under which a cold test of 25 deg. F. or even higher would be perfectly satisfactory. In the ammonia cylinders of ice machines, for example, a zero cold test oil is absolutely necessary. In ordinary bearings which are not exposed to cold weather the cold test is a matter of no importance.

Of all of the laboratory tests before mentioned, viscosity is the most important, as this denotes the body or relative fluidity of the oil. Mineral oils can be manufactured of almost any desired viscosity, and the conditions under which an oil is to be used determines how viscous it should be. In general, light swiftly-moving machinery requires an oil of low viscosity, heavy slow-moving machinery requires an oil of high viscosity; but the viscosity required must be determined in each individual case by the conditions under which the oil is to be used. The body of an oil should be such as to form over the bearings a film of oil just sufficient to keep the surfaces apart under conditions of maximum speed and pressure. An oil too heavy in viscosity produces unnecessary heat, due to the internal friction of the oil. An oil too light in viscosity allows actual bearing contact, with a corresponding bearing wear and an increase in frictional heat.

Viscosity is the only one of the tests mentioned above, except in some instances cold test, which has any bearing upon the suitability of a lubricating oil, but an oil might be correct as to viscosity and still prove to be a poor and inefficient lubricant. For example, an oil which has a tendency to decompose and form deposits which will gum up the machine and thereby increase the friction, is obviously to be guarded against, as also the oil which contains ingredients that will corrode or pit the bearing metal. None of the above tests, however, will give the slightest information as to this tendency of the oil. Every precaution should be taken by the oil consumer to guard against such an oil, in other words, he should purchase an oil which is carefully manufactured from a superior crude.

The best practical guide as to the suitability of an oil for any particular purpose is the amount of frictional heat produced with that oil in use under actual working conditions. Frictional heat denotes wasted power, and is determined by the difference between the bearing temperature and the room temperature.

In a typical case, for example, bearings running at an average temperature of 101 deg. F., with a room temperature of 71.8 deg. F., that is to say, a frictional heat of 29.2 deg. F., were reduced to an average of 91.6 deg. F., with a room temperature of 71.7 deg. F., that is, 19.9 deg. of frictional heat. This means an actual reduction in frictional heat of 9.3 deg. F., or 31.8 per cent.

The best way to determine the relative values of 2 or more lubricating oils and the method that is now being generally adopted by large consumers, is to have an engineer make an actual test under working condi-

tions to determine which of the oils under consideration reduces the frictional heat to the lowest point. The question of comparative cost also naturally enters into the selection, and this is determined by computing the cost of lubrication for a certain period, the 2 factors being, first the amount of each lubricant necessary to secure perfect lubrication, and second, the cost per gallon of the lubricant. The cost per gallon may be somewhat high, but the reduction in consumption more than offsets the difference in original price, the net result being more economical lubrication for any given period. In considering the cost, however, the ultimate cost should always be considered, and in computing the ultimate cost, the loss of power, and the wear on equipment due to unnecessary friction should be given first consideration.—Lubrication.

Jeremiah Judson, C. E.

Where the Steam Went to

"WELL, SIR, boys, it seemed today as if I would miss the meeting tonight in spite of everything. It seems that about every so often—sometimes oftener—there is a run of events about the job that sure do get a fellow going up looney lane. First thing this morning, the house pump lost its vacuum, and while we were advertising for it one of the shaking grates in No. 3 boiler took a notion to fall into the ashpit, and before we had the fire cleaned away and a new one dropped into place, and the steam coaxed back from 125 to 150, where it belongs, the condenser went democratic."

Thus spoke Kelsey, as he bounced into the hall one meeting night about half an hour ahead of schedule time and found the rest of the "immortal eight" seated around the stove each with a piece of some newfangled metallic packing in his hand examining it critically.

"Well, what has that got to do with the war in Europe, Airup, Irup or Syroup," butted in Hank Mistele as he transferred his sample of packing to the other hand while he lit his pipe. "You look just as good as new yet. What's the joke?"

"Fish," answered Kelsey as he hung his overcoat on a peg and banged his cap on top of it.

"Fish?" replied Foster, as he looked up with an injured expression. "Fish, Mr. Kelsey? I suppose it was stuck crossways in the river and dammed the water up so that it flooded the boiler room and put the fires out. Do you take us for pickerels or suckerels?"

"Fact," reiterated Kelsey, with emphasis, "and it wasn't stuck crossways in the river, because it was so big that it couldn't get crossways without moving the tannery on one side and the woolen mill on the other side of the river out of the way."

"Well, now, how big *was* the fish when you got it out of the foot valve," queried Jim Dutcher, who had been there himself.

"Oh, about a pound and a half," and Kelsey joined the circle around the stove. "But it seemed that today was my trouble day, for no matter which way I turned, it seemed to be due for something to happen that you couldn't foresee or prevent. Did you fellows ever have a day like that?"

Jerry Judson reached over and carefully placed his piece of packing on the secretary's desk and filled his pipe again. As he lit it and dusted his fingers off by scraping them past each other, the rest felt that he was warming up the low pressure to tell another story.

"Well, sir, that reminds me of the time, years ago, when most of you fellows were still firing or wheeling out ashes," began Jerry, and the rest of the pieces of packing were carefully laid on the secretary's desk, while the pipes were freshly filled with colored waste, "and I was running 'ingine' at that same woolen mill."

"That sure was some plant," began Jerry, after working up a strong draft, "and it was built on the job-lot principle, and the destinies of it were presided over by Sandy Harter, who, I believe, is out west some place now.

"At that time, the sole motion apparatus was an old bed 'slid' valve engine, 15 by 30, made at the old Dickey plant that has also passed on to the discard. This engine had single bar guides and the square end of the connecting rod strap fit pretty close in the crosshead as the crankpin was at about 45 deg.

"It was the habit of Old Lucius Harter, Sandy's father, to come down to the mill every few days to see that everything was all right and not advanced in ideas from what it was when he was running the dump, 40 yr. before—and the engine was an old one even then.

"He never failed to come into the engine room and pet that old scrap pile and tell me the dollars and cents that it cost and how he loved it and all that stuff, you know. He used to feel it all over and say, 'you're a good old ingine yet, ain't you, old Nancy?' and tell me how that it understood him.

"Well, one day, I guess the engine was not feeling pleasant, and when old gent put his hand on the slow-moving crosshead, as he had done hundreds of times before, his finger slipped into the space behind the rod, and when it came over the center, it nipped the end off the old man's finger. Ever after that he never came any farther than the door.

"I went there the first week in January, during a cold snap, when it was about 15 below or so. The valves and stems all over the plant leaked so that you couldn't see the gage on top of the water column till about 10:00 a.m. All this fog condensed on the inside of the single board roof, and when it warmed up during the day, it began to drop off till everything was wet.

"Sandy Harter came in one day and said, as he looked up at the suspended shower, 'Say, Jerry, ain't there some way that we can get rid of this water dropping?—oh, my eye! my eye!' as a big drop lit in his optic. That was the last of that.

"One of the boilers was only a year old at that time, but the other was 22, with a lever safety valve, a 5-in., that leaked like a strainer. I do not now recall the weights of the 2 balls on the 4-ft. lever, nor their position, but I do recall that they figured to relieve the boiler at just 256 lb. And every other Sunday this

boiler was on the job alone on account of the fire pump.

"The first Sunday, I examined the lever safety valve, and the valve and seat looked as if the rats had been gnawing it. So, to keep going, I soldered both and ground them in, and after throwing one ball in the corner, set the other back a foot or so from where it was, to relieve at 5 lb. more than the pop on the new boiler.

"I took measurements of the valve, turned a wooden pattern and had one cast and machined before the 2 weeks were up; but do you know, that soldered valve held tight till the day before cutting the boiler out, when it began to sizzle a little.

"About this time I began to notice leaks in the girth seam over the bridge wall of the old kettle, and I called in Fred Wratten—you remember him, boys?—the boss at the boiler shop—to look at the case. While we were squirming around on the grates to get a good look at the seam, he threw his arm out to help him turn over and he brought up against my right ear, where you see that scar, with a sharp cold chisel.

"Well, we found 22 rivet cracks—one for every year of the oiler's age. That settled it. This, with a thin place all around the handhole plate in the bottom of the rear head (where you had to get into the combustion chamber to see if it had fallen in under pressure) made me do something desperate. I divorced the 2 boilers, put the new one on the engine alone, boosted from 90 to 115 (built for 125), and put the old one on the fan, dye tubs, heating coils, etc., dropped to 60 lb., and had the old man wire for the inspector.

"If you ever have tried to feed 2 boilers at different pressures with one pump, you can appreciate what this proposition meant. Well, I finally got the old man to buy a new boiler, but that is getting ahead of the story. The pump was the only means of getting water into the boiler except by a pail. I urged the old man to buy an injector, using the argument that if the pump broke down, he would be up against it, not only for running but for the insurance, for, no pump no steam, no steam no fire pump, and no fire pump, no insurance. Well, he came across, and—I'll be hanged—that injector hadn't been in service over an hour before that rattlety duplex pump broke a piston rod square off in one of the water plungers. Gee, but that was a close shave.

"There was an old closed heater that came over in the Mayflower, hid back of the jet condenser, and the exhaust steam paid a visit to it on its way to the condenser. Still the pipes from the heater to the boiler were never hot enough but what you could put your hand on them, just 140 deg., as we found.

"So I got out a search warrant one Sunday, and forced an entrance to the heater, and behind the lower plates was solid with dirt and hardly moist. There was a plate a third of the way from the top, and the dirt was up to this level. The water left at the top, of course, and was supposed to enter at the top and pass to the bottom through a pipe, but this was broke off at a coupling near the middle plate. I also boiled ¼ in. of cylinder oil off the inside of the tubes at this time.

"Well, there was more soil in that heater than there is on a mountain farm in Arkansaw, and after we got going again we got water at over 200. But the change was too sudden and the heater began to leak. Well, sir, by adding about $20 to what we sold the old copper tubes for and the heater shell, also, we got a new heater.

"By this time I had excavated all of the solidified packing out of the numerous valves around the plant and had put in some real packing so that you could really enjoy life there. The cylinder was fastened to the box bed—or was supposed to be—by wedge studs on the bottom, passing through holes in the bed, and a wedge driven in.

"Along about the time Washington crossed the Delaware, I guess by visual observations, the cylinder began to 'wink' on the bed, then to wiggle, and then to move, and by the time that I arrived on the scene, it took a nice little journey northwest and southeast at every stroke. So I pried the cylinder up to place one Sunday and took a chance that it was not so far out of line as it had been, and drilled a half-and-half hole on each side, where I had a good chance to get in with a ratchet, and put in a dowell. New wedges made out of a file helped to hold the cylinder down.

"I kept a record of the coal burned every day, and it began to drop a little, although big enough yet. Then one day that old jet condenser just naturally stopped, and no amount of language would budge it. So we dug into the steam end just for spite. Well, we found the Chinese puzzle pretty well on the bum, the worst feature of which was the fact that you could put a strip of tin between the valve and the seat on the port bridges, and the valve would fit all round without any trouble.

"Being built at an early day, the valve seat casting was removable and I soon had this on a machine and the valve on another being faced off, and scraped to a fit. This occupied possibly 2 days, all told, with a few other little things, and during that time, with the engine running high pressure, cutting off at ⅞ of the stroke, using live steam to heat water which was formerly secured from the hotwell at about the right temperature, my records showed that we saved over a ton of coal a day, with the *condenser out of service.*

"The 'old man' didn't enthuse much about it at all. Took it all as a matter of course. But when we got the condenser on the line again, we saved another ton still, although we were not getting over 8 to 9 lb. of vacuum. In about a week, the condenser stopped again, and the old man was charitable enough to tell me that I had spoiled it the time before.

"This time it was the water end, and when I took the head off, I found just 57 pieces of the water piston. No, boys, that ain't no joke. There were 57 pieces, for they made me think of pickles. But the front and back plates were intact. This saved my bacon. The brass liner was worn about the shape of the inside of a nail-keg, so I had to devise ways and means to keep going till we got repairs from Boston.

"I made a wooden head out of alternate layers of ½-in. maple and basswood laid with the grain at an angle of about 45 deg., till I got a thickness of 3 in., put the front and back plates on and driving the head in past the small end of the liner, with a piece of shafting, soon had the old mill going and the water soon swelled the wood to fill in the barrel where it was worn.

"But the funny part of it was that in about 2 or 3 hr., when the wooden head had a chance to swell out to place, we got 12 lb. of vacuum, as against 9 before.

Old Snee, the boss dyer, said that he had been on the job there for 30 yr., and he never saw that clock say anything more than 9 yet. Well, we will give him the benefit of the doubt anyway.

"Things now began to get a little better. But somehow or other the old man began to get a little off his feed. He would come in and look around, say nothing, open the fire door and look in and then hike. It made me think of the gulls hovering over the harbor before a storm.

"Well, one Monday morning as I came into the boiler room (he couldn't do it Saturday) there stood a strange man. The Superintendent told me that 'the old man' wanted to see me in the office. Of course, I thought that he was going to raise my pay $5 a day or so; they all think that; but—he didn't. He met me at the door, and kindly but pleasantly informed me that I had cost them more for repairs in the several months that I had been there than all the engineers—all of them, mind you—that they had had in 5 yr.

"I explained that this was why I cost them so much, but that the coal records showed that I was burning less coal per day by 2 tons than was the custom when I first began. Well, he said that business was not so good as formerly, and other lame excuses, and also said that the coal had to be burned anyway.

"Well, he carefully tied the proverbial can to me and turned me out. But right then and there my luck turned. By 10:00 that morning I was running at the ladder factory, at better money, and me with a week's wages in advance from that old woolen mill, right in my jeans.

"Not only that, but I had also drawn plans for a new header, etc., to connect the boilers, when the new one arrived, and the old man gave me, I think it was $15, for them, and never used them.

"Three weeks later, I got a letter from the old man asking me to come over to his house that night, so, thinking that he at least wanted to see if I was losing weight, I went over, and stumbled into the monthly meeting of the Board of Directors.

"They asked a few questions about the header plans that appeared to be but an excuse, and soon the old man blurted out that he thought that perhaps they had been too hasty and had made a mistake and wanted to know if I would come back again.

"I replied that I found that I hadn't make a mistake and that I didn't care to go back. Well, do you know, from that day on, as long as I stayed around these parts, before the old man went west, he never lost an opportunity to show that he had changed his opinion about me, and put himself out many times to do me a favor."

"Say, you Indians, don't you know that it is 8 o'clock? Cut out that gab and square around against the wall there, and—you, you, Lundgren, take your hat off. We are going to hold meetin' tonight." "Bing," and President Bert Ellis brought the gavel down on the remains of the old head-stone on his desk with a bang like a 6-pounder.

ALL SUPERHEATERS should be provided with outside spring type safety valves set slightly lower than the boiler valves to insure a flow of steam through the superheater in case the load was thrown off the boiler. This will prevent overheating the superheater.

Brake Horsepower

KINDS OF BRAKES; CALCULATIONS. BY G. W. MUENCH

WHEN making a short test on an engine, whether steam or gas, where no definite load is being driven by the engine, it is necessary to make use of a brake of some kind attached either to the flywheel or to a pulley on the crank-shaft. In this sort of test it is of vital importance to handle the brake properly and get the proper measurements. The indicated horsepower shows the power developed by the engine, including the power necessary to drive the moving parts of the engine; the brake horsepower is only the power actually delivered to the brake. This may mean either the greatest amount that it is possible to deliver under the best conditions, or the actual load on the engine at any time while giving service.

Figure 1 shows a common form of lever-arm prony brake attached to the flywheel. The brake consists of an iron band around the flywheel and held in position by a bolt passing through an ear on each end of the band. Between the band and flywheel face are bolted 2 levers, having their outer ends fastened together. This forms a firm lever which rests on a knife edge supported by a pedestal on a platform scale. The rotation must

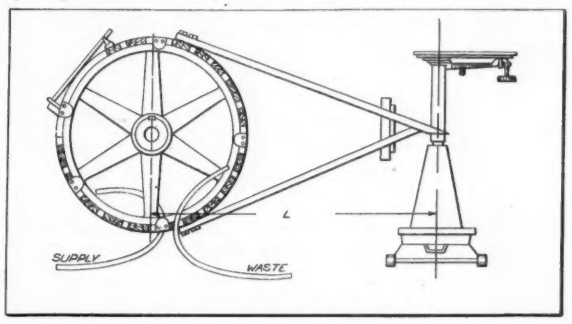


FIG. 1. PRONY BRAKE

in this case be clockwise. By tightening the long bolt, the wooden shoes are held more firmly against the flywheel and in this way any desired load may be obtained, and by tightening up to such an extent till the engine speed is reduced the maximum brake horsepower may be obtained. In order to be able to run the engine long enough to get good results, it is necessary to provide some method for cooling the flywheel or pulley on which the brake is operating. This is done as shown in Fig. 1 by leading water to the inner surface of the rim. Centrifugal force keeps it on the rim and carries it around. On the other side is a pipe which is so placed that it picks up the water and leads it to a drain. When this form of brake is used the brake should be put in place on the engine and the lever arm allowed to rest on its block on the platform scale. This dead weight should always be subtracted from the reading obtained while making the test to determine the brake horsepower. The lever arm is always the distance from the center line of the flywheel to a parallel center line passing through the knife edge on the scale, as shown in the figure. The knife edge on the pedestal resting on the scale should be on a level with the center of the brake wheel.

In Fig. 2 is shown a common form of rope brake, one not used as much as the wooden-block brake. It has, however, several advantages. In the first place, it is simple to make and is light and portable. It also makes it possible to get more uniform load on the engine, and therefore causes less vibration, and makes it possible to get more accurate scale readings. The one care necessary with a rope brake is to prevent stretching. The pulley or flywheel must be cooled to prevent rope from charring and burning. Figure 2 explains how this form of brake is built. Again, as before, we must be sure to use the net scale reading for the horsepower calculations. In this form of brake, the frame to which the rope is fastened should be close to the brake wheel. The length of the lever arm in this type is the radius of the pulley plus ½ the rope diameter. A great many other forms of prony brakes are used, but all are the same in principle.

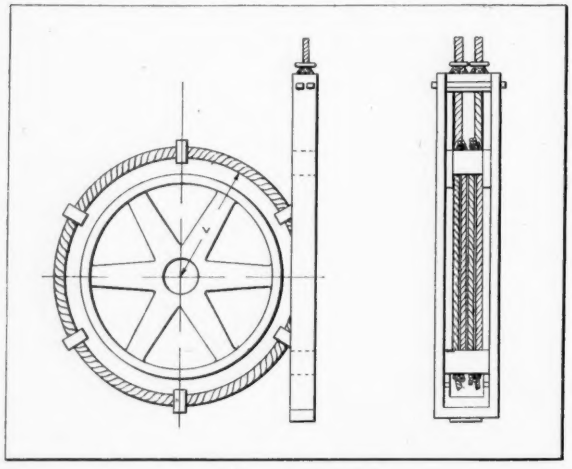


FIG. 2. ROPE BRAKE

Regardless of the form of brake the formula for figuring the results is always the same, and is as follows:

B.hp. = (2 × 3.1416 PLN) ÷ 33,000, or (6.2832 PLN) ÷ 33,000;

Where P = the net pressure on the scale in pounds.
L = length of the lever arm in feet.
N = the revolutions per minute.

This formula can be readily explained in detail and probably then be more easily understood. Assume the lever to revolve with the shaft and wheel carrying at its end a weight equal to the net weight on the platform scale. The distance through which this net weight (P) would travel per revolution would be the circumference of a circle whose radius is the length of the lever arm, hence the 2 × 3.1416L in the above formula. But multiplying this distance by the weight P, would give the foot pounds of work per revolution; multiplied by the speed would give the foot pounds per minute; this divided by 33,000 gives the horsepower that would be necessary to drive the engine against the pressure P and keeping the lever arm stationary, as the engine must overcome the friction at the brake. Since both 6.283 and 33,000 are always constant, the formula can still further be simplified thus: b.hp. = 0.000,19 PLN.

Again referring to the ordinary prony brake, suppose a series of tests were to be made with the same lever area but at various speeds, the calculations can be further simplified and time saved by figuring the result of 6.283 L ÷ 33,000, which will remain the same for all tests. It is, however, often advisable to use different lengths of lever arms, if this can be readily done; then, of course, the result obtained above will change with the change in lever arm. If, for a certain series of tests and certain lever arm, this constant has been ascertained, it is only necessary to multiply this result by the speed and net load on the platform scale.—Gas Power.

Recording Thermometers

SELECTION AND CARE OF THESE USEFUL BOILER ROOM ASSISTANTS. BY L. B. SWIFT

UNTIL the last few years, thermometers found little use in steam generating plants. If the feed water temperature, condenser water temperature, flue gas temperature, etc., fluctuated widely, it mattered little to the engineer as long as the desired steam pressure was maintained. But the up-to-date engineer recognizes the importance of knowing the exact temperatures existing and of keeping a careful record of these data.

The recording thermometer which gives a continuous record of temperatures for every minute of the day and night is unquestionably one of the most valuable assets

RECORDING THERMOMETER SHOWING CASE, TUBE AND SEPARABLE SOCKET

that can be added to a boiler room equipment. By using a thermometer of this type, the engineer in charge can at any subsequent time check up the exact conditions of operation and, if the temperature of the flue gas, feed water, condenser water, or steam, has varied too widely, he can take steps immediately to correct any existing faults. The recording thermometer makes it unnecessary to depend on the readings taken from an indicating thermometer of the glass tube form which is fragile in construction and often connected in an inaccessible location where the light is poor and reading difficult.

The illustration shows a type of recording thermometer that is extensively used. The capillary tube system is of cold drawn steel, sufficiently flexible to be bent into any desired position; it is so rugged that it requires no

protecting tubing, and it can be made in any length required to permit locating the case where observations may be taken conveniently. This tube system is filled with a solid column of mercury under high pressure extending from the coil in the case through a very fine bore in the capillary tube into the bulb or sensitive member at the end. If the temperature of the bulb is varied, the increase or decrease of pressure, due to the changing volume of the mercury in the bulb, is transmitted through the capillary tube to the coil in the case. As the coil opens or closes, its motion is transmitted to the lower extremity of the pen arm and the pen is thus moved across the temperature scale graduated on the chart. The 10-in. chart is carried on the arbor of a clock so that it can be revolved in any period for which the chart is graduated. One of the features of this recorder is the patent sealing device which prevents adjustment of the pen by unauthorized persons. The case is nicely finished in nickel and the front is securely locked. Charts can be supplied with any range of temperature from minus 40 to plus 1000 deg. F., and with any period of revolution to suit best the requirements of the installation.

A form of connection convenient in the power plant is the plain bulb with adjustable clamp flange, adapted to connection to flue gas uptake. The bulb should be projected well in toward the center of the flue so that it will be subject to good circulation of the gases and the flange should be placed at the point of entrance of the capillary tube into the flue.

For taking temperatures of feed water, condenser water, steam, etc., the plain bulb form of connection could not be used, since the bulb as a rule is connected into a pipe line. The separable socket form here illustrated is, therefore, invariably employed. The socket is a well, machined from one piece, bored and taper-reamed to accurate dimensions to fit exactly corresponding tapering stem surfaces of the bulb which is slipped into it and seated to perfect contact by means of a swivel nut. The socket is threaded with 1-in. standard pipe thread so that it can be screwed into a pipe and left permanently attached, thus permitting the removal of the thermometer bulb at any time without closing down the circulating system, since no water can escape while the socket is in position.

Care should be exercised in the selection of a thermometer to insure that it is adapted to the work for which it is intended. It is not uncommon to find the bulb of a thermometer installed in a short piece of pipe screwed into a tee so that just the lower tip of the bulb projects into the pipe line, this, as a rule, being done when the pipe is not of sufficient diameter to allow the bulb being screwed directly into it. Correct temperature indications cannot possibly be obtained under such conditions because the larger portion of the bulb is "pocketed" and therefore not in good contact with the medium of which the temperature is desired. The thermometer will give the temperature of the medium surrounding the bulb, but this obviously is of no value. When the diameter of the pipe into which the bulb is to be connected is small, a cross should be used, the opening opposite to the one in which the bulb is attached being plugged. By using a cross, the cross-sectional area of the pipe is sufficiently increased so that the bulb does not tend to stop the flow. Very often a bend in the pipe will permit the installation of the thermometer bulb so that it lies parallel with the flow and good results can be obtained by this method.

It is also not infrequent that a thermometer with separable socket form of connection is attached to the uptake for taking temperatures of flue gas. A short explanation will make it clear why an installation made in this way will give results greatly in error. The socket is metal and therefore a good conductor of heat; gas or air is a very poor conductor of heat. Therefore, with the thermometer stem projecting only 4 or 5 in. into the flue and the outside air at a temperature several hundred degrees below that of the flue gas, it will be seen that the heat will be conducted along the metal bulb to the outside of the flue, where it will be radiated much more rapidly than the flue gas can supply heat to the bulb, and the result is a temperature reading much lower than the true temperature of the flue gas.

These are only 2 instances of what often occurs, but they prove the necessity of considering carefully the existing conditions and of selecting thermometers properly constructed to fill the requirements to good advantage.

From the Nation's Capital

POWER PLANT NEWS IN CONGRESS AND THE DEPARTMENTS. BY A. P. CONNOR

THE cause of the boiler explosion that caused great damage to the ship and crew of the war ship San Diego in the harbor of San Diego, Cal., on Jan. 21, has been determined to have been due to the valve located in the main suction line having become loosened by the jarring of the boat and machinery. This caused the water to several boilers to be cut off. Several of the boilers were severely burnt but only one exploded. Nine men died from the effects of the explosion, 4 at the time of the accident and 5 since. Their deaths were mainly caused by scalding and the shock.

The important proposed legislation concerning the development of power from the water resources of the U. S. lands or under the control of the federal government was not enacted by Congress before adjournment, and it is expected that the acts will be reintroduced during the next session. Great interest was shown in the Bills treating of this legislation and many important hearings were held for the purpose of properly considering them. The Bills were passed through the House of Representatives and the Senate acted upon them favorably, and sent them back to the Committees, who then reported favorably; but the Senate did not act again upon them, so that the Bills died.

Though the reason why these Bills were not acted upon, may have been due to the rush of business during the last days of the session, there are indications that the Bills were not entirely satisfactory and that they could not be passed without discussion and amendment, which, of course, was out of the question during the last days of Congress. The financial stringency caused in the government's affairs by the war that is tearing Europe, through lack of revenue from imports, etc., also influenced the outcome of legislation that involved the use of money, and some would have been necessary in

these cases for administration purposes. Some congressmen believed that the delay in the legislation would tend to remove or bring to light the flaws in the Bills, and it was better to delay them.

Another Bill of interest was that referring to the establishment of a Bureau of Labor Safety, which was intended to investigate the dangerous environments of working people and provide means for safe-guarding their health, limbs and life. After a favorable action on the House and Senate side of Congress it was eventually dropped, or rather not acted upon.

The idea of making battleships more like central power stations with electric feeders running to all the parts of the vessel to provide the power to operate the various devices of the same, including the screws or propellers, appears to be becoming the policy of the U. S. Navy, and it is expected that the future battleships will have the system or scheme embodying it, very highly developed. The system has been used in the ship Jupiter and has been successful. This radical change from the use of steam to operate the devices on board a ship, as well as the long shafts from the engines to the propellors, was first thought of and used in the U. S. Navy, and it has been found to be successful, and it is surmised that the future great merchant ships will substitute it for the non-electrical and time honored systems now used.

Reduction of Power Costs

INCOMPETENT ENGINEERING RESULTS IN AN UNNECESSARY ANNUAL OPERATING EXPENSE OF $5000; REARRANGEMENT OF PLANT ELIMINATES THIS WASTE. BY T. K. ROBERTS

THAT money can be wasted by careless engineering is illustrated by a case which recently came to the writer's attention. A factory devoted to both wood and metal working was spending approximately $5000 per yr. for fuel, although it was generating but 300 hp., and had to dispose each day of a large quantity of wood refuse. Investigation revealed that the expenditure for fuel was almost entirely unnecessary, and that the plant could be so rearranged as to utilize all the wood refuse, and dispense with coal except in certain periods.

Steam was required not only in the dry kilns, but also in certain other departments. Based on the use of live steam, the heat required in the processes and in the heating system was about ½ of that required for generation of power.

Investigation revealed the following principal causes of excessive expense in the operation:

Condensing engine too large for the power required; use of live steam in the processes and for heating, instead of utilizing the exhaust steam from the engine; inefficient arrangement of the boiler plant preventing full advantage being taken of the wood waste available for fuel, and also causing the coal used to be burned uneconomically; lack of concentration of manufacturing processes, necessitating an excessive amount of steam for heating in cold weather.

ARRANGEMENT OF PLANT

THE PLANT comprised 2 horizontal return-tubular boilers, rated at 200 hp. each. These supplied steam to a 500-hp. cross-compound Corliss engine, belted to a line shaft, driving jack shafts and counters. The engine exhausted into a jet condenser, a vacuum of about 28 in. being maintained. Indicator cards taken with the plant in full operation showed that about 300 hp. was the maximum demand. The entire engine room equipment, including auxiliaries was of the finest character, no expense having been spared to obtain the best that was possible.

Conditions in the boiler plant were, however, just the reverse of those in the engine room. While the engine equipment had been installed with all the refinements for high steam economy, in the boiler plant it would hardly have been possible to design a worse arrangement. The 2 boilers were set in between the boiler-house walls, with no passageway on either side or between them, making them almost inaccessible for cleaning and repairs. They were also set low, making the construction of an adequate furnace impossible. The grate-bars were set but 24 in. below the boiler shell, and the space in back of the bridge wall was filled up solid to the level of the bridge wall. Such a furnace might have done for anthracite, but for bituminous coal it was most unsuitable and for sawdust and wood waste it eliminated all conditions necessary for proper combustion. A simple observation of the boiler plant, without any tests, made it evident that one of the causes of the high cost of power was the arrangement of the furnaces, and indicated a probability of large savings if the boiler settings were redesigned.

STEAM REQUIRED BY DRY KILNS

THE PRESENT practice is to use live steam at a pressure of 90 lb. per sq. in. to supply this heat, and as each pound of steam at 90 lb. contains 1007 B.t.u., 1029 lb. of live steam were required per hour. If exhaust steam should be substituted, under a pressure of 2 lb., there would be available in each pound of steam 972 B.t.u., thus requiring 1066 lb. per hour.

USE OF WOOD REFUSE

WITH AN efficient boiler plant, an evaporation of 7 lb. of water per pound of coal could easily be maintained with the grade of coal available. Under the existing conditions of live steam heating a total of 2415 tons of coal per annum would be required if coal alone were used as fuel and an evaporation of 7 lb. maintained. There was actually used 1250 tons, indicating that the balance of the steam had been generated with the wood waste. A logical deduction from this, that wood waste, equivalent to 1165 tons of coal was available, and if provision were to be made for burning it efficiently it would be possible to reduce the coal bill still further than it would be reduced by simply changing to exhaust heating.

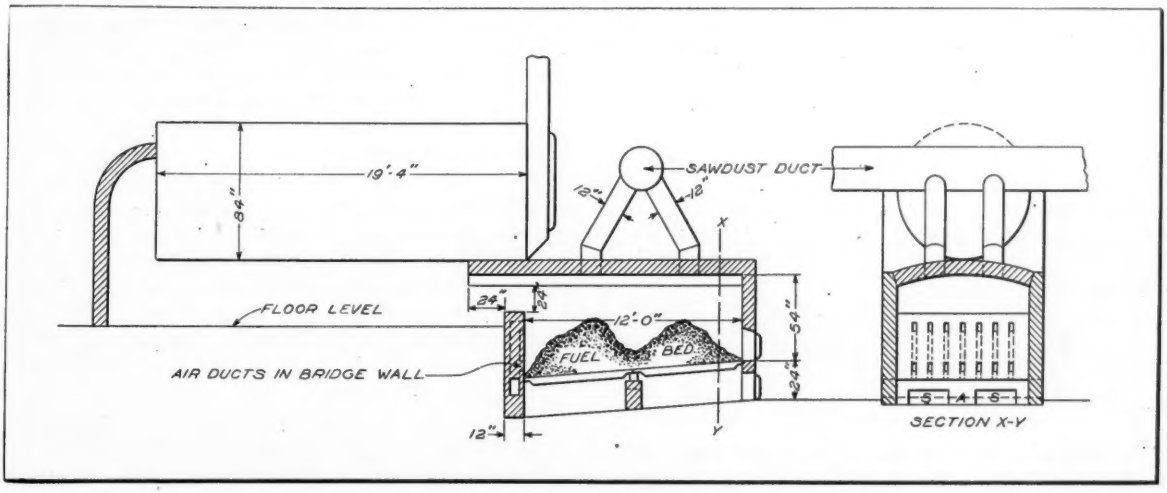
It is entirely probable under the furnace conditions which existed that it would be doubtful if an evaporation

of over 5 lb. of water per pound of coal could be obtained. The furnace, as already pointed out, was entirely unsuited for bituminous coal, and for wood waste a worse furnace could not have been designed. Limited space in the furnace necessitated almost constant firing and the fire doors were therefore open practically all the time, exposing the furnace to heavy inrushes of cold air which could not fail to reduce the economy. To be conservative, however, the evaporation was assumed at 6 lb. per pound of coal. Under the present conditions of live steam heating and a 6 lb. rate of evaporation in the boilers the coal required would be 2792 tons. As the coal purchased was 1250 tons the wood waste must be assumed as equivalent to 1542 tons of coal. Similarly, with a 5 lb. rate of evaporation, the coal required would be 3350 tons and the wood waste equivalent to 2100 tons of coal.

With the plant rearranged to use exhaust steam for all heating purposes the annual steam requirements were:

Engine, 306 days at 75,000 lb. per day....	22,950,000 lb.
Dry kilns, 306 days at 14,406 lb. per day..	4,408,236
Dry kilns, 59 days at 24,696 lb. per day..	1,446,064
Heating system, 150 days at 5114 lb. per day	767,100
Total steam required per year....=	29,571,400 lb.

With an evaporation of 7 lb. per lb. of coal, there would be required for this purpose 2112 tons. But it has already been shown that a large quantity of wood waste was available, which was the equivalent at the lowest estimate of 1165 tons of coal, thus making necessary the purchase at the outside, of 947 tons of coal provided the furnaces were redesigned to take full advantage of the possibilities of wood fuel.



ARRANGEMENT OF BOILERS FOR THE EFFICIENT BURNING OF WOOD WASTE

Changes Recommended in Boiler Plant

Changes recommended in the construction of the boiler plant are shown in the illustration. The requisites for burning highly volatile fuel are: The gases must be distilled from the fuel slowly; when distilled, the gases are to be brought into intimate contact with very hot air; while burning, they are not allowed to come in contact with comparatively cool surfaces, such as the shell or tubes of the boiler, all conditions violated by the original furnace. For the burning of wood waste, not only are the above enumerated conditions necessary, but in addition the combustion chamber must be of especially large dimensions if complete combustion is to be effected.

As originally constructed, the boilers were set so low as to make it impossible to obtain a combustion chamber of the requisite size beneath them. Furthermore, a furnace underneath the boilers necessitated firing through fire doors which was undesirable on account of the volume of cold air admitted during the periods the doors were opened for firing. Wherever possible, it is desirable to blow wood-waste fuel into the furnace without opening the doors, but on account of the clogging action of sawdust, but little air can penetrate the fuel bed through the grate bars, which was the only regular means of air supply in the former construction. The combustion of sawdust is almost entirely on the surface of the pile and practice demands that the air for combustion be blown into the fuel bed with sufficient velocity to penetrate the surface and stir it up. These conditions were fulfilled by the construction recommended. A Dutch oven, extending in front of the furnace for a distance of 12 ft. and having a minimum distance from the grate bars to the top of the arch of 4 ft. 6 in., now provides ample grate area and combustion space for handling all the wood waste of the plant. To obtain this height, it was necessary to excavate in front of the boilers, bringing the fire-room floor 3 ft. below its present level. The bridge wall was moved forward to the front of the present furnace and continued up until the distance between it and the top of the arch was 24 in. The bridge wall was made hollow and provided with air ducts through which air could be blown into the surface of the fuel bed. In its passage through the bridge wall this air becomes preheated and thereby materially assists in the combustion. As it enters the furnace in a direction counter to the flow of the gases distilled from the fuel, these gases and hot air become thoroughly mixed, which mixture is completed by the air and gases passing together through the narrow throat between the bridge wall and

the arch. The arch is extended a short distance beyond the bridge wall in order that the combustion may be completed before the gases come into contact with the shell of the boiler.

As it is possible that coal alone will be used as fuel at certain periods, the ash pit was divided by wall A midway of its length. Through this wall 2 openings S were provided, which can be closed with ordinary ash pit doors when burning coal. Were this construction not adopted, the excessive grate area would permit the passage of large quantities of air, materially cutting down the efficiency of the furnace. It would be almost impossible to keep the gate bars covered with coal. With wood waste as fuel, the openings S are left wide open to permit the passage of such air as may find its way through the grate bars into the fire. The principal dependence, however, for air to support the combustion is placed upon that introduced through the bridge wall and through the ducts supplying fuel to the furnace.

Four openings were provided in the roof of the furnace through which the wood refuse was blown from the duct carried across the top of the furnace as shown. The spouts of these openings are removable and covers are provided by means of which the openings can be closed when coal is used.—Industrial Engineering and The Engineering Digest.

Pumping Natural Gas

EQUIPMENT FOR A COMPARATIVELY SMALL STATION. BY NAT G. PUMPER

IT would seem that few people have any conception of the amount of power, or the extent of the investment utilized in the pumping of natural gas throughout the large sections of the country.

We have what is comparatively a small station, located 5 miles from the railroad, for which all material was hauled on wagons, the heavier parts being hauled on a wagon specially constructed, fitted with 10-in. tires, anti-skid rings and steering gear, the combined weight of the heaviest part and wagon being considerably over 40 tons, and requiring 42 draft horses to pull it.

Here we are in the mountains, with buildings of structural steel, sheathed with galvanized iron, the main building being 74 by 95 ft., with a well ventilated basement 10 ft. high. The floor is of concrete, carried on I beams, with curved corrugated sheets between the beams, and the concrete reinforced with twisted steel. Between engines is placed a wrought iron grating, to light and ventilate the basement. Through the day, ample light is secured by a large number of windows, and at night, on account of the danger from fire and explosion, all buildings and the grounds are lighted with incandescent lamps, having fuseless receptacles, and with non-arcing fuses on a switchboard in the auxiliary engine room.

In the main engine room we have 3 1300-hp. twin tandem gas engines, direct connected to 6 gas compressors, which are 15½ by 48 in., both engines and compressors being built by the Snow Steam Pump Works, of Buffalo, N. Y., and designed to pump against a normal pressure of 350 lb. per sq. in. from an intake within the limits of single stage compression, the normal speed of the units being 88 r.p.m. The engines are guaranteed to operate, however, when necessary, continuously against a maximum pressure of 375 lb. per sq. in., and actually 385 lb. has been carried for several weeks, with a daily average of 95 r.p.m.

For the year ending August 1, 1914, these engines ran 19,006 operating hours, with an oil consumption of 7569 gal., or less than 0.4 gal. per operating hour, including all oil for auxiliary engines. The fuel per operating hour was 9570 cu. ft., or less than 10 cu. ft. per hr. per hp.

In the auxiliary room, which must furnish a continuously supply of water, electric current for lighting the buildings and charging the storage batteries, and air for starting the main engines, there are 2 units, each consisting of a 60-hp. Westinghouse 3-cylinder vertical gas engine, driving a 37.5-kw., 125-volt, direct connected generator, and a 2-stage air compressor through a friction clutch. These air compressors furnish air at 175 lb. into 3 air-storage tanks, from which the supply is drawn to start the main engines.

To supply water for the engine jackets, there are 2 units, each with 1000 gal. capacity, consisting of an electric motor driving a centrifugal pump, and in this same building is located, also, a boiler for heating purposes, and a small but complete machine shop; and this is not a big pumping plant either. Some of the larger ones have from 13 to 15 engines, ranging from 1000 to 4500 hp. each, so that the gas pumping industry is quite a large and lusty infant.

Why do we not hear from some of the engineers of such stations in regard to their problems, and how they are solving them?

How To Order Gears

BY N. G. NEAR

IN case of gear breakage in the power plant, it is usually considered a "difficult stunt" to order a new one for replacement because of the various definitions of pitch, tooth curves, etc. A common practice is to send the broken gear to the factory, store, or wherever the new one is to be procured so that the seller will surely furnish a duplicate.

A good and quick way to order duplicates is simply to lay the gear on a sheet of paper and with a sharp pencil draw the outline of the remaining whole teeth on the sheet. Also trace the size and shape of the shaft opening and keyway on the paper. Then, by giving the thickness of the gear at the teeth, the length of the hub, and other important dimensions, the seller will be able to duplicate the gear with exactness and it will save him from making most of the measurements himself. The paper method is by far the least expensive.

This method is much the best where the gear is not entirely put out of commission, as often happens. Sometimes a gear is used for some time even after one of the teeth is broken out. And again, where a pinion, for instance, is to be replaced by a noiseless gear, the above method is of service.

There is nothing startlingly new about this scheme, I know, but engineers seldom think of it when ordering renewals.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Trouble with Crank Brass

A CRANKPIN box on a 16 by 36-in. Corliss engine recently gave trouble, and as it was badly worn, a new one was made and fitted by a machinist. This new box ran warm; it was removed, scraped carefully and replaced.

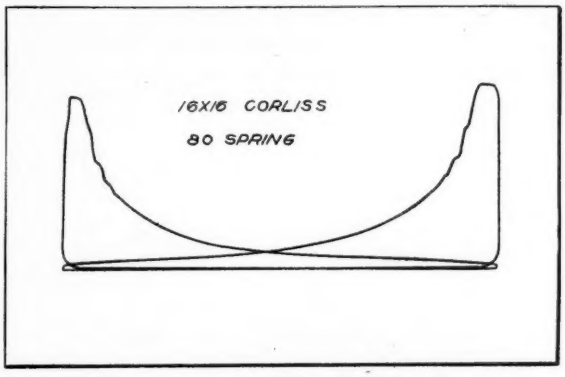


FIG. 1. CARD FROM CORLISS ENGINE SHOWING NO COMPRESSION

It gave trouble again, running warm and pounding; the babbit was squashed somewhat. The machinist then suspected something was wrong with the valve setting, so an indicator was applied. The accompanying card was the result. The engine was running condensing and had

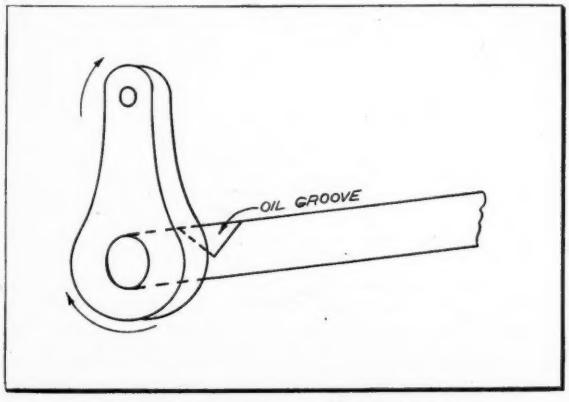


FIG. 2. OIL GROOVE CUT IN SHAFT

no compression. During the winter, the exhaust steam was used for heating; when this was discontinued, and the condenser cut in, the valve setting was not altered, and trouble began to pile up. Compression was given, and since then there has been no more trouble with crankpin brass.

Another case of hot crankpin box was cured by application of cup grease. The engine was an old timer, having gridiron steam and exhaust valves. The engine was given an overhauling and a new crankpin pressed in. A new crank brass was made and fitted. When the engine started up, this brass ran warm; so it was removed and scraped—it was not babbited—and the crankpin polished with emery cloth. Again the brass ran hot, and again this process was repeated. The third time, the brass warmed up, so a grease cup was filled and put on the pin, and from that time on there was no more trouble. Both engine oil and cylinder oil had been tried.

The main bearing of an 18 by 42-in. Corliss ran warm in spite of all the engineers could do. Different grades of oil and grease were used on it, to no avail. As a last resort, they cut an oil groove, as shown, in the shaft, with the angle of the groove pointing in direction of rotation. Since then, they have had no trouble with a hot bearing. TOM JONES.

Tubes and Columns

IN HIS criticisms of the article appearing in the Jan. 1 number, under the heading Boiler Accessories, F. R. Daly thinks that water columns should be so placed that the water when just showing in the glass, would be at the level of the tubes. With columns so placed, many firemen and water tenders would keep a fire going as long as water showed, just as they do now, and many more boilers would be ruined and lives lost or endangered than at present. The reason for placing them as at present is to have a margin of safety, and any man in charge of a boiler who will fire a scoop full of coal after the water has disappeared from the glass, should be discharged on the spot. As it is, many men will keep the boiler steaming as long as water shows, not stopping to think that a great deal of water is evaporated after the last coal is fired.

I have had charge of a plant for 3 yr., that after pulling a heavy load would suddenly shut down and the water would fall down from a gage and half out of sight. At the time, there would be a hot fire under these boilers. If these columns were 3 in. lower and we carried water at the usual height in the glass, I'd "be with the angels now." This margin of safety is observed because of the human element. Might as well ask, why make shell plates thick enough to stand 500 lb. pressure, then put on a safety valve that will hold only 100 lb.

I used to think a boiler was incomplete unless the column connections had valves on them. They were so handy. I remember a small boiler I had charge of once, that was so fitted. In the winter it was the custom to pump up to 3 gages and let the fire die at night, but to keep the steam on the heating system; this, with a 100-lb. pressure at quitting time. Then to keep the low water

alarm from blowing or in case the glass should break, I would shut the column off. In the morning, I never had more than 1 gage of water, sometimes not any. I would open the column valves and let the city water run in till I had 2 gages. But I came in one real cold morning and looked at the glass and there was 2 gages of water. I hurried and got the fire going and stood around a while trying to get warm. As the steam got up to the working point I blew the column and nearly fell down when the water didn't come back. I pulled that fire in a hurry and then just remembered that I had not opened the valves. I opened them and the water was about out of sight. If a boiler is not in condition it should be taken off the line. The column is an indicator of its condition, and if it is out of order the boiler should come off. Many things can happen that may call a man's attention away from a repair job for a minute or 2, and then he may forget to come back.

About leaving the blowoff open, this has happened and helps to illustrate the danger of leaving any job on the boiler to do another. In spite of being warned never to leave the blowoff while blowing down, a friend of mine once had the water get too high and carry over. He went to blow down and then came around in front to see when the water got down to 2 gages. While standing there a glass broke on another boiler; instinctively he ran and closed it off (the glass connections) forgetting the blowoff until the boiler was about ½ empty and burning a number of tubes. He lost his job for taking his hand from the blowoff while it was open.

The statement that insurance companies' arguments against valves have no weight, because explosions mean business for them, is certainly wrong. Insurance companies do not make money by explosions, but by preventing them.

Mr. Daly refers, in his article, to a water column having 1¼-in. connections and a ¾-in. blow-down pipe, and cites that as a reason for having valves in the steam and water line. Wouldn't it be more reasonable to tap out the column for a 1¼-in. blow-down line? In his sketch he shows a column with a valve or cock in the steam connection with a whistle on it. But you cannot put a whistle on the water connection, and what would happen if that were left closed?

And while it is expensive to kill a boiler, it is better to do so than to endanger life by unsafe and unnecessary fittings. Safety First! H. SKATON.

READING the article entitled Tubes and Columns, on page 273, March 1 issue, by F. R. Daly, in regard to having valves in the water column connections, I am with Mr. Daly. I believe I would not feel right if there were no valves in the water column connections on boilers under my charge, as I could relate many instances where I was glad of having valves in the connections.

The steam gage connections from the water column to the gage where renewed at boiler cleaning (gage is located a few feet from the column). A few days later, it was noticed that the steam gage connection was clogged up somewhere. In closing the 2 valves in column connections and taking the pipe apart, it was found that scale and dirt from the new pipe had nearly stopped up one of the nipples near an ell so the steam gage would not get full boiler pressure.

Another case was that where a fireman happened to strike one of the try cocks with a fire poker, and ruined it to such an extent that it leaked badly. The 2 valves in water column connection were closed and damaged cock was removed and a plug put in its place until a new try cock was obtained.

Still another case where the valves in column connections were used to good advantage was that of a 1¼-in. flange union located between the valve and column on the water connection. The gasket started to leak badly one afternoon; after shutting down time that night, the steam was lowered as much as possible, in the boiler, then the 2 valves closed in the column connections and a new gasket placed in a short time, and the plant was ready for operation the next morning. Now, had there been no valves in the column connections in this case, all the steam would have had to be let out of the boiler as well as the water run down in the boiler below the opening of the water connection, thereby wasting water which was at the steaming point and had cost coal. H. A. JAHNKE.

Simplex Steam Pumps

WHEN I took charge of this plant the fireman told me that the Burnham feed pump was worn out, that the other engineer had taken it apart several times and could find nothing wrong only that it could not be depended upon to keep going, so it must be worn out. When this pump refused to go, the boilers were fed from the house service pump; that is, a part of the discharge water from the house service pump was fed into the boiler feed line. This condition of operation was not satisfactory, and I was satisfied that the Burnham pump was only sick and not worn out, so I proceeded to find the ailment.

The pump would run along sometimes for a half hour or so fairly well, then by slightly checking its speed by closing the throttle valve a little the pump would stop, sometimes at one end, sometimes at the other; changing the blocks on the valve stem would shorten the stroke but would not prevent the pump stopping. Bumping the valve stem with a block of wood, first one way and then the other, would sometimes start it again, but the only way it would keep going was to give it lots of throttle and floods of oil. This could not be done, because at this speed the boilers soon became full and the pump had to be checked or shut off, and if only checked, it soon shut itself off and would remain stopped with the throttle open.

Examination of the steam end showed the main piston in fair condition, but rings loose; main valve and seat in good condition; pilot valve and seat in good condition; steam chest piston and rings worn very loose and leaking badly.

The cure in this case was to bore out the steam chest and fit in a new steam chest piston with new rings, also a new set of rings in the main piston.

When the parts were assembled again, and the blocks on valve stem adjusted properly, this worn-out pump worked like new; it could be throttled down almost to a stop and still keep moving.

At another time, while employed as an assistant engineer in a steam electric power house, the chief undertook to make a simplex pump work. This unit was

an independent steam-driven jet condenser, and would stop occasionally. There was a "starter" always on hand for these occasions, consisting of a piece of 4 by 4-in. oak about 30 in. long, shaved down at one end to form a handle. By beating the valve stem with this club, the valve was reversed and the pump would start off again. This starting device was designed by the chief and his cure was about as creditable.

Three different times he took the steam end apart and decided the trouble was in the main valve and seat; that they were worn and were leaking. He proceeded to face them up with a flat bastard file, and after filing for some time, took emery flour and ground valve and seat together to finish the job. It is needless to add that these heroic efforts failed to correct the trouble. He next decided to put new rings in the steam chest piston. He asked the machinist to have the forge department make up a piece of steel large enough so that the 4 rings could be turned from it; the rings were to be machined and then cut open, same as iron rings, and then the chief wanted them tempered.

The proper cure for this pump was to bore out the steam chest and fit in a new steam chest piston with new rings. There was no trouble at all with the main valve or seat.

I have so far found simplex steam pumps absolutely reliable, and far superior to duplex pumps in efficiency. The steam chest piston is the secret of success in these pumps and must be kept in good condition and reasonably steam tight, then a fine working, reliable pump is assured.

H. W. BENTON.

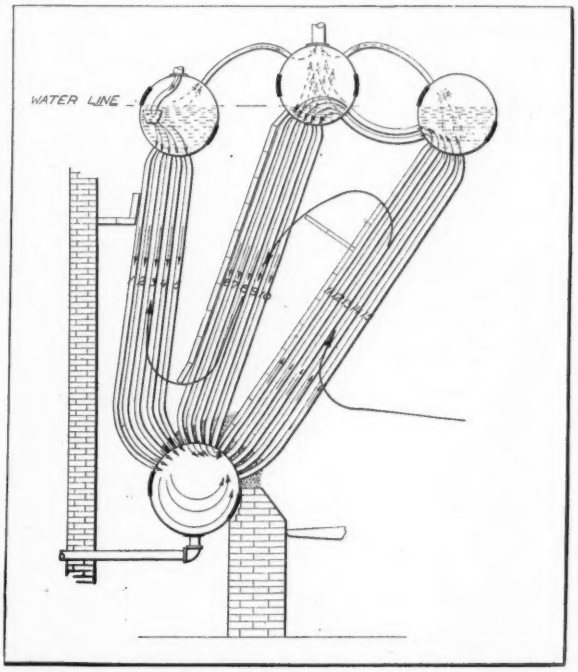
Beading Stirling Boiler Tubes

I READ THE several comments on this subject in the March 1 issue, with a great deal of interest, for the reason that I had agreed with the statement of Mr. Wallace that there was no important reason for beading the tube ends.

The arguments advanced are, that if not beaded there will be a steam or air pocket above the end if the tubes at the top of the mud drum which would leave the plate unprotected by water, and it would be liable to become overheated and might be fractured. I believe that this is true only as far as theory goes. Let us see how much air or steam space there would be at this point, assuming that some of the rows were exactly on the top, and that each tube of the row extended through the sheet not less than ½ in., the diameter of the drum being taken as 48 in., and from the formula we have $\frac{4H^2}{3}\sqrt{\left(\frac{2r}{H} - 0.608\right)}$ = area, or $\frac{4 \times 0.5^2}{3}\sqrt{\frac{2 \times 24}{0.5} - 0.608} = 3.25$ sq. in. area. The length of the drum is taken as 8 ft., which would give a volume of 312. sq. in., or 0.18 sq. ft., and the width of this space would be about 6 in. If there was any scale in the mud drum, this space would be considerably less.

As for an air pocket remaining at this place, it is well known by engineers that water has an affinity for air, especially when under high pressure, which is the reason why the air chamber on a pump does not stay full of air. Assuming that this air is trapped as stated, the surface exposed to the water is so great in comparison to the volume that it would be absorbed by the water in a short time, and furthermore this 0.18 cu. ft. of air at atmospheric pressure when compressed to a pressure of 125 lb. would have a volume of about 0.02 cu. ft., assuming that there was no scale present to assist in reducing the space.

From the study of the drawings of the Stirling boiler, and from the 5 yr. experience I have had in operating them, there are at least 2 other reasons why I do not agree with the statements made, that there is liable to be damage done at this point. From the accompanying sketch, you will notice that the feed water enters the back drum, passes down the rear bank of tubes to the mud drum, thence across the drum to the front bank, up the front bank to the front steam drum, where the steam generated is separated from the water and passes through



CIRCULATION OF STIRLING BOILER FEED WATER

the steam tubes to the middle drum, and the water passes through the 2 rows of circulating tubes to the middle drum, thence down the middle bank of tubes to the mud drum where it mixes with the incoming water from the rear bank, and again passes up through the front bank. There is, of course, considerable steam rising from the second bank; but, as the front bank is subjected to the greatest heat, the circulation is as shown, and is probably quite rapid. This action I believe will prevent the formation of steam bubbles at the point in question, and will also carry any steam or air so formed with it for the reason that the flow of water coming from tube No. 6, which would be hotter than the water from the rear bank and for this reason would hug the top of the mud drum, would be broken up by the projecting ends of tubes 7 and 8, which are on top, and would tend to wash the steam and air along with it to tube

No. 11 in the front bank. Furthermore, the wet steam which would occupy this space, if there was any at all, would be some protection to the drum, as it has some heat absorbing properties. The main reason that overheating would not be likely is that in actual practice the space between the tubes on top of the drum is covered with soot and fine ashes, as shown in the sketch, to a depth of from an inch or two to a foot or more, and which has nearly the same insulating properties as a similar thickness of scale. The location of this accumulation of soot is such that it cannot be readily blown out with the tube blower, and will be found in all boilers of this type. Considerable soot will also be found between the tubes in the front bank on the top of the drum, as shown in the sketch. This condition, I believe, will cause the mud drum to get the greater part of its heat from the water circulating through it, rather than from the fire, and would keep the temperature of the plate so low that there would be no danger of its overheating.

The direction of the path of the hot gases is the same as the circulation of the water in the front and middle banks, and in the opposite direction in the rear bank. This brings the hottest gases in contact with the part of the boiler carrying the hottest water, and flowing in the same direction, and the cooled gases are in contact with the colder part of the water, causing very rapid circulation. As the mud drum is suspended from the tubes which in turn are carried by the steam drums, the reason for beading the tube ends, if it is done, may be to assist in supporting the weight of the parts suspended. There is no good reason for its being done, but it does no harm.

In regard to rolling and belling the tube ends, it may be done at one operation. The seat is rolled first, then the rollers are loosened and pulled back a little, which brings the rolls a little over halfway outside the sheet, and the plug is tightened again and the end expanded about ⅛ or 3/16 in. This does not loosen the tube in the sheet, and it is not necessary to reroll it in the sheet. The holding power of the tube, however, is greatly increased.

About 7 yr. ago, we retubed a B. & W. boiler, putting in 126 new tubes. The roller expander used was of the type furnished by this company, which has an adjustable collar that fits against the tube end to control the position of the rollers in reference to the header. These tubes all projected through the header the same distance, and the front end was rolled in tight with the rear end, being held to prevent the tube slipping until it was tight. Then the rear end was rolled in the same manner. After they were all rolled, the expander was adjusted to bring the rolls about ¾ their length outside the header, and the ends were slightly belled. This is very easily done, as the metal stretches easily. The seats were not rerolled. The working pressure of the boiler was 150 lb., and the hydrostatic test pressure put on was 225 lb. There was not one leak in the entire 252 rolled joints. Belling the tube end does not interfere with the tightness of the tube in the sheet or header as much as will be done in beading it over, in which case the tube should be rerolled after beading, as pounding on the beading tool will loosen it in the sheet.

J. C. HAWKINS.

Why Treated Belts Should Not Be Overloaded

A BELT ENGINEER gave me a few pointers the other day that I think will be of interest to all users of belts.

This engineer is a belt treatment enthusiast. He believes in keeping the belts nice and pliable all the time so they will grip easily and run properly without slipping. He believes in slack and easy running belts—no high initial tension for him.

He says, however, that there is one great objection to the slack belt, and that is: users are liable to overload it. Most belt men seem to think that when a belt is running slack it isn't pulling full load. It doesn't look just right for one side almost to touch the other. We have become so accustomed to tight belts—high initial tensions—that we cannot rid ourselves of the idea readily.

So, when the time comes to increase capacity or load, the operator of the slack belt says, "Well, this belt handled the old load so easily that I am sure it can handle a great deal more, so we won't buy a new belt."

This is all wrong. A leather belt cannot stand up to more than a definite stress day in and day out and year in and year out. Stress that is too great will quickly stretch the belt and ruin it. It will break prematurely.

Treating a belt does not make it stronger. It simply makes the belt more pliable, waterproof, and longer lived. The same formulas that are used when computing untreated belts should therefore be used when computing the treated ones. The belt will then be amply strong and in most cases (though not always) it can be run slack. In every case, the belt can be run "easy" at least.

The rule that is most used for 1-ply belts, because it is usually well within the limits of safety, is this:

"A single-ply belt, 1 in. wide, running at the speed of 800 ft. per min., will transmit one horsepower."

For 2-ply belts the rule is:

"A 2-ply belt, 1 in. wide, running at a speed of 500 ft. per min., will transmit one horsepower."

N. G. NEAR.

Removing Back Pressure Causes Trouble

A PAIR of simple engines was put in to operate against a back pressure of 20 lb. gage, the exhaust being utilized in the plant.

One day it became necessary to remove this back pressure due to conditions in the mill. As the engine was provided with double eccentrics, the exhaust valves were set with a liberal opening with the wristplate in the center, owing to the high back pressure carried, and yet ample compression was obtained.

When the back pressure was removed, the engines began to pound hard and the result was that the babbit in the crankpin boxes was pounded out of shape, coming out between the end of pin on each side and heating so it was necessary to stop to readjust the bearings and after cooling off, the run until 6 p.m. was completed when both crankpin boxes were rebabbited.

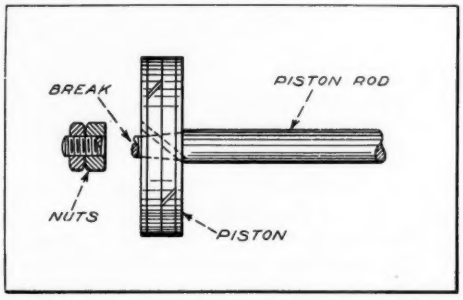
When conditions like this come up, it is better to stop and move back the eccentric to get the needed compression and thus save further trouble. RECEIVER.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Piston Rod Repair

ENGINE 73 came in last night with the piston rod on the air pump broken off as shown by the sketch, which also shows the method of quick repair. I drilled a 9/16-in. hole through rod and piston as shown by



BROKEN PISTON ROD AND REPAIR

the dotted lines and drove a steel pin, filing it flush with the bottom of the piston. The engine was turned out with a delay of only 47 min. T. M. STREET.

Repairing a Trap

ONE OF my steam traps, connected to drain the main steam line, had a piece broken out of its head flange, as at A, in Figs. 1 and 2. At this place, there was a bad blowing and leaking of steam. Frequent renewing of the gasket and use of grommets on the nuts and bolts were of little use. I then hit upon the scheme of cutting

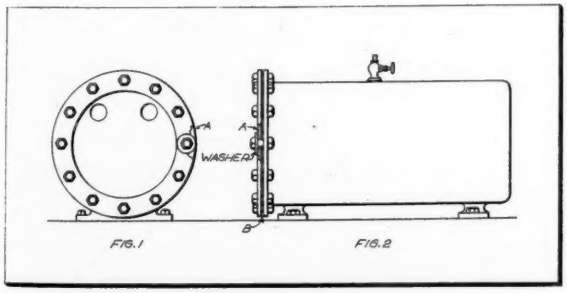


FIG. 1. END VIEW OF TRAP SHOWING DAMAGED HEAD FLANGE

FIG. 2. SIDE VIEW SHOWING DAMAGED HEAD FLANGE

the gasket in Fig. 3 at the center of the holes on the line at c. The gasket then appeared as shown in Fig. 4. When this was put in, and the bolts drawn up even and square, it held tight, and has given no further trouble.

Using this sort of gasket allows a space between the faces of the flanges at their outer edges, which permits them to be drawn closer together than the inner edges. This clamps the gasket tightly at the bolt holes and outer edge.

This trap is used to drain a line in which the pressure is almost constantly at 260 lb.

C. H. WILLEY.

Emergency Repairs

WHILE ANY work of a temporary character around a steam plant is an undesirable thing, there are times when a makeshift is warranted by the circumstances of the case, even though the work is of the most flimsy kind and makes one think of the small boy's definition of a lie: An ever present help in the time of trouble, but an abomination in the sight of the Lord.

We have quite a number of steam and return pipe line from outlying buildings to the central heating plant. These pipes are run underground, in many places 10 to 12 ft. below the surface. They are protected by outside coverings of pipe of several kinds, the most satisfactory being carried in old cast-iron water

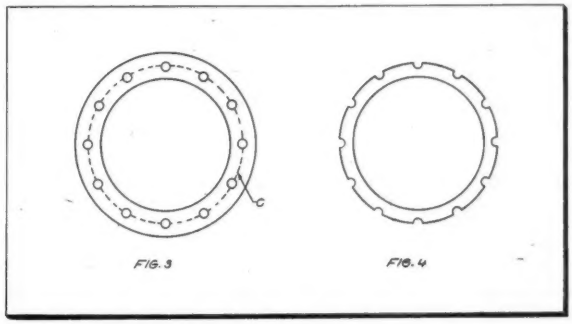


FIG. 3. METHOD OF CUTTING GASKET
FIG. 4. GASKET AFTER BEING CUT

pipe from an abandoned water works plant, with leaded joints; however, that's another story, as Kipling says. I want to tell of how we stopped some leaks in these underground steam lines.

On several occasions, on digging down to these leaks and taking off the covering pipes, the steam pipe was found so corroded and thin, both from inside channeling due to condensation running along the bottom, and outside corrosion, due to the leakage of ground water entering through the covering pipe, that it would crush on being clamped. In one instance, the steam pipe, after being cleaned off, had a hole ¼ in. wide and 6 in. long, besides several cracks or splits from crushing when an attempt was made to clamp it.

It was impossible to take time to renew the pipe, as it was necessary to have steam going through it in less than an hour; so the 4-in. pipe was first wrapped with one layer of sheet gum packing, letting the packing extend 3 in. over the hole in the pipe. Over this sheet packing were wrapped 3 layers of No. 12 cotton duck and around the duck were wound 2 layers of 3/16-in. cotton cord. The cord was wound with the turns as close together as possible and as tight as it could be pulled. Over this wrapping was placed a coating of Portland cement mortar about 5 in. thick. The mortar was reinforced with some scraps of ¾-in. chicken wire mesh which was handy.

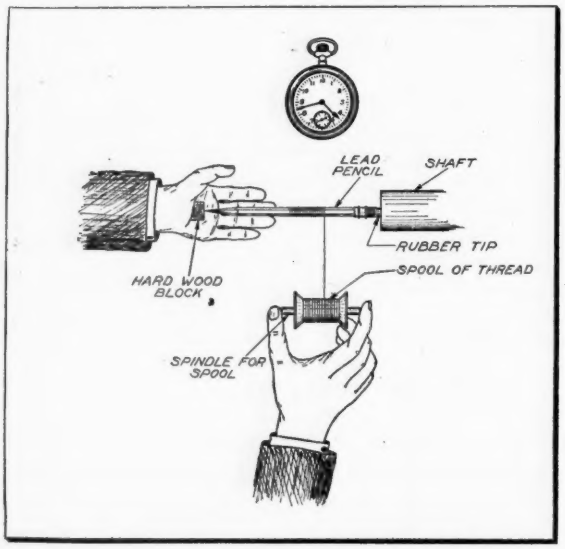
The moisture from the mortar enters the cotton wrapping and so tightens it that there is absolutely no leakage. I have patched 5 places in this way and have had no leakage from them, though 2 have gone through 2 seasons under 10 lb. steam pressure, and when taken up, the patch seemed the most reliable part of the work, and the cotton duck and cord seemed good enough to have been used again if it could have been freed from the cement.

T. H. DeSaussure.

Homemade Indicator

I show herewith a simple homemade speed indicator that can be made to do good accurate work by a careful operator.

Tie a thread from a wound spool onto a lead pencil. Use the lead pencil as a winding spindle as shown. The rubber tip provides good slipless contact.



SIMPLE HOMEMADE SPEED INDICATOR

Allow the pencil to take thread from the spool for, say, 5 sec. by the watch. The number of turns of thread on the pencil, then, multiplied by 12 gives the r.p.m.

Although this device is confessedly "not in it" with the manufactured article, it does very well in a pinch.

N. G. Near.

Altering a Press Piston

The drawings show the construction of a press piston used for an occasional lift of about 6 in. with a sustained pressure for 5 or 10 min. This press was originally operated by steam and the piston fitted with 2½-in. square packing rings as shown. The cylinder bore is about 12 in. The press was later changed over to hydraulic operated.

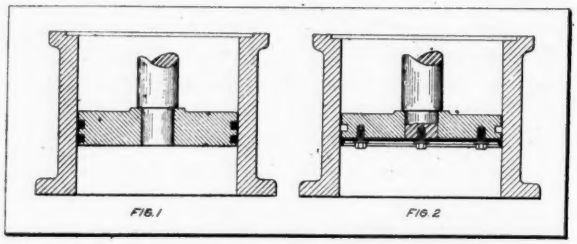


FIG. 1. SECTIONS OF THE PISTON IN ORIGINAL FORM
FIG. 2. SECTION OF PISTON AFTER ALTERATION

Trouble was experienced after a time because the packing leaked and the proper pressure could not be obtained. The piston was then altered as shown in the drawing. The lower part was turned off up to the first packing ring groove. The original form of packing was discarded and a cup packing ring was fastened to the bottom of the piston, as shown. This alteration enabled the press to be operated without any further trouble. The pressure used was about 100 lb.

John Leafstrom.

A Safety Precaution

Recently, I saw a workman try to run a belt off a pulley by pulling the driving side, with the pole under the belt as in Fig. 1. Result: The end of the pole was caught between the belt and the pulley; the pole was yanked out of his hand and sailed up against the ceiling, smashing both pole and ceiling.

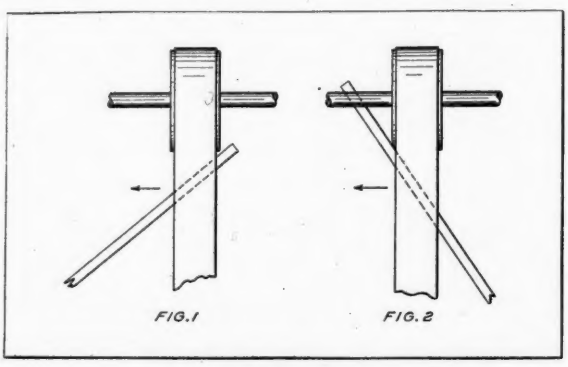


FIG. 1. THE POLE GOT CAUGHT
FIG. 2. NO DANGER THIS WAY

If the end of the pole had been kept on the opposite side of the shaft, and the belt pushed off the pulley, as shown in Fig. 2, the pole could not have been caught.

Receiver.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Trouble; Pump Questions; Valve Setting

How is a vacuum caused in a boiler, and is it dangerous? If so, why?

2. In case of vacuum in a boiler, what is to be done before firing up?

3. What would you do if the front end of a return-tubular boiler had settled or lowered 2 in., for some reason or other? What would be dangerous about it besides the settling of sediment over the fire, or the safety plug being higher than it ought to be?

4. How can you tell whether the check valve in a low-pressure boiler (in return pipe) is leaking, without closing the main steam valve, which is dangerous, with steam pressure on, and without using hydraulic pressure?

5. What is to be done if the blowoff breaks in a single boiler plant? In a boiler cut in with others?

6. If the blowoff broke in a boiler connected with one or more other boilers, what effect would it have on the water in the other boiler? Would it raise or lower? Would you keep the pump or engine running, or start it or stop it, as the case happened to be?

7. What is water hammer in a boiler; in a heating system; the cause; the danger if any; and the remedy?

8. What is the danger in connecting a boiler carrying 100 lb. pressure, with another one carrying 70 or 75 lb., even if you open the valve ever so slowly? Is there no way of doing it without danger?

9. After a boiler had been idle for a long while, what would you do before starting up; what particular attention would you give to manholes and handholes?

10. Can you return condensation from a radiator on the level with the boiler floor, back to the boiler, using either high or low steam pressure? Can it be done without using a pump, injector or lifting trap, other than the trap on boiler?

11. Why use a pump if you can use traps, thereby saving purchasing cost and running cost of former? Could we get along without a pump or pumps in any or all cases? If so, would it be economical?

12. How do you set the valve on an Ames engine? How is the valve balanced? How do you change the lead?

13. What type of shaft governor is used on a riding cutoff valve? Why?

14. What types of shaft governors change the lead with the cutoff; and what types do not, and how?

15. Describe the operation of steam and valves in the steam chest of a Deane simplex steam pump?

L. G.

A. If a low-pressure boiler is connected to a heating system, when the entire system is at the temperature of the steam, and then allowed to cool rapidly, as if the fire be covered with fresh fuel or make-up water added, a partial vacuum will be formed in the entire system if the air valves are sealed by the heat of the steam in the usual manner.

This condition will continue until the valves have cooled enough to admit air, when normal conditions will prevail again. If artificial means are used to establish a vacuum in the heating system, such as is commonly used, and a wet return be used, any unbalancing of the system will cause the water to rise in the wet return, and this might lower the water level in the boiler to the point where it will uncover the soft plug, or the tubes or crown sheet as the case might be.

If a dry return is used, this will not occur unless the return is located slightly above the water level in the boiler, in which case the drop in the water level will be excessive. The remedy is to place a check valve in the return as close to the boiler as practicable, preferably swing check, with the valve as near vertical as possible so as not to retard the flow of the returns to the boiler.

2. Should it be found that a vacuum exists in a boiler and if there is any doubt as to the true water level, it is best to break the vacuum by opening a valve to the atmosphere before firing up.

3. If a boiler of the return-tubular type has settled so as to lower the front end 2 in., find out the cause and then restore the boiler to the proper level. If the boiler rests on the brick setting, burning out the firebox or deterioration of the setting in general or settling of the foundation as a whole, at one end (as in the case of soft ground), will cause the boiler to be out of level.

If suspended by hanger rods from a steel framework, the forward supports alone might settle and cause the trouble.

No matter which way a boiler settles, it places a severe strain on pipe connections, as these have been installed under normal conditions, and the chance of fracture in pipe lines under boiler pressure is increased many times with the consequent danger that is obvious.

4. Shut off all the radiators, or as many as possible, and then hold the hand on the system side of the check valve and note whether the return pipe continues to warm up toward the system. If the fire is covered with fresh fuel so as to cause a partial vacuum in the boiler, this process will be hastened.

5. Whether you have several boilers or but one in a plant, what you would do in case the blowoff pipe broke, all depends on where it broke. If it broke off outside the valve, close the valve if possible, and if not, dump the fire or cover with ashes or fine, wet coal, if circumstances will permit. If the break is in such a position

as to be dangerous even to close the valve, or if between the valve and the boiler, don't try to be a hero. Lives are worth more than boilers.

The writer has known an instance of this kind where it was possible to get at the pipe inside the valve without great danger; a sledge was used to hammer the pipe flat and this served for a few days till the inevitable Sunday.

The writer also has had a blowoff pipe stick when open, caused by a left-over rivet getting into it, which is just as bad, and the emergency was met by driving a tapered pine plug into the end of the blowoff pipe (1½-in. pipe) which kept the plant on the job until Sunday.

6. Here, also, circumstances alter cases. If there were but 2 boilers and fully loaded, it would be necessary to reduce the demand for steam, but not by stopping the pump; rather the engine, or some of the live steam outlets. In this case, the water would rise in the remaining boiler slightly owing to the excessive ebullition when the entire load was thrown onto it.

In a plant where there are a number of boilers connected to one system, they usually have nonreturn valves on to prevent loss of more than the contents of the disabled boiler. Here usually, the loss of one boiler is not so serious a matter, as its share of the load is taken up by the remaining boilers. The water supply to the disabled boiler should be shut off as soon as possible, so as to insure a supply to the remainder.

7. Water hammer in a boiler is the violent movement of the water in it, caused by some unusual outside influence which momentarily increases the outflow of steam, the stoppage of which causes the water to return to its normal level with considerable force. The strain set up by the sudden release of the steam which causes the water in the boiler to be held more or less in suspension, is considerable, and when coupled with pitted, grooved, or crystallized plates, will cause a rupture and probably a disastrous explosion.

Water hammer in pipes, the audible evidences of which are well known, is the rapid movement in the pipe, or radiator, of condensate flowing rapidly into a partial vacuum, caused by the advance of the column of steam striking the cold pipe or water lying in the pipe.

There is considerable danger from water hammer in pipes, especially if the steam is turned on quickly, such as ruptured fittings and valves. In fact, the actual rupture may be some distance from where the water hammer takes place.

The remedy to both inquiries in this question is the reverse of the cause; viz., if necessity compels the rapid withdrawal of steam from the boiler, close the valves gradually, and in case of pipes of a heating system, turn the steam on slowly, giving the pipe time to warm slowly.

8. If the steam from a boiler under 100 lb. pressure be admitted to one carrying but 70 lb., for example, the sudden rise in temperature in the second boiler will cause strains, and if the second one is capable of carrying not to exceed 70 lb., the pressure will then be considerably above the safe working pressure and a combination of these 2 effects may cause an explosion.

The writer has known of instances where boilers were cut into the line from those already under working pressure, when the gage showed but 5 or 10 lb. This practice should be condemned in the strongest terms as extremely dangerous. It may be done with impunity a number of times; so can one handle nitroglycerin and other explosives with considerable carelessness—a few times. But there is never a good reason for endangering life and property by continuing the practice, as cited in the inquiry.

9. Steam boilers are all too frequently laid up just as the fire died, and a stranger to the plant might find it necessary to place them in service again. They should be swept and cleaned, inside and out, and thoroughly examined for corrosion, etc. This is liable to take place around handholes and manholes. Gaskets on these plates are liable to deteriorate when the boiler is out of service.

10. It is possible to return condensate from radiators on a level with the boiler floor, or from steam separators, or other apparatus under boiler pressure, directly back to the boiler without using artificial means. This can be done by using what is known as a steam loop. In principle, the steam loop consists of a riser, a horizontal pipe and a drop-leg. At a considerable height above the water level in the boiler, the riser empties into the horizontal pipe and this in turn into the drop-leg.

Local conditions and differences of pressure at the boiler and at the receiver, govern the size of the pipe and the height of the riser. Its use is not common, as the conditions where it can be installed to advantage are rare and usually another method of disposing of the condensate is at hand.

11. While traps of certain design can and do work satisfactorily when feeding water directly to a boiler, yet the method of controlling their action is not so sure and certain, for one might desire to feed more or less water temporarily, owing to sudden demands for steam. While pumps for boiler feeding purposes as usually encountered, are generally wasteful of steam, this is more or less reclaimed in heating feed water, and being simple, they are seldom out of service, even under trying conditions, and continuity of service is the prime consideration. Where pressure in the city mains is high enough, it can be, and is, frequently used as the sole means of boiler feed; but it has the disadvantage that, the more steam pressure is reduced, the greater will be the quantity of water admitted through a given sized feed pipe or through a valve opened to admit just the proper quantity of water under a higher steam pressure.

12. The Ames engine has a flat balanced double-ported valve, functioned by either a Sweet or a Robb-Armstrong-Sweet governor, and operates under a flat balance plate which is held in place by adjusting screws which permit end adjustment so that the dummy ports in the balance plate can be set to correspond with the steam and exhaust ports. The balance plate is permanently kept at the proper distance from the valve for easy running in a steam tight condition, by 2 strips of iron which are from 0.002 to 0.004 in. thicker than the valve itself.

To set the Ames valve, remove the balance plate and ignore it for the time being. Adjust the eccentric rod to secure the proper travel of the horizontal carrier arm

on both sides of the swivel pin. Then adjust the valve stem so that the valve has the necessary lead at each end which naturally varies with the size of the unit. This is presuming that the valve travel is the proper amount which is determined at the factory of the builder. This travel is determined by design and trial, and like everything else, improves with practice, till the position of best results is located, when lugs are cast in the wheel as limit stops for the governor in both extremes of travel. Also, the eccentric, or eccentric pin, as the case might be, being attached to the wheel, the lead is determined by the position of the wheel on the shaft, and this, also, is fixed at the builder's shop; so, if one desires to change the lead, which is seldom necessary, it must be done by advancing or retarding the position of the wheel on the shaft and putting in an offset key to suit the new conditions.

Having set the valve to suit, place the engine in a position where the balance plate can be easily matched with the main ports, which you will usually find to be with the valve just opening at, say, the crank end. Suppose that this opening will just admit a small piece of tin. Then put the balance plate in place and adjust it endwise till it shows the same admission at the dummy port, the thickness of tin, as at the main port. Check up at the other end. Put in the pressure spring and replace the chest cover.

13. Centrifugal shaft governors are usually used on a riding cutoff valve, as they possess certain features of rigidity which, coupled with the large mass of metal in the weights, does not affect the regulation when the motion of the 2 valves reverses in the cycle of operation.

14. When the angle of advance only is changed, decreased cutoff means more lead. When the eccentricity only is changed, increased cutoff means more lead. A combination of these 2 principles should give a variable cutoff with constant lead, and single-valve automatic engines now designed and equipped with some form of inertia governors attempt to produce this effect, and succeed fairly well.

If the angle of advance only is varied with an engine having a single valve, the cutoff is changed and the lead is changed, frequently in a manner that is not desirable. To describe or illustrate these several methods of accomplishing the desired lead and cutoff, would require considerable space.

15. You do not state whether you refer to the Deane of Holyoke pump or to the Dean Bros. pump. Both firms make a simplex, or single cylinder, pump, but the action of the steam valves is quite different in the 2 machines.

In the Deane of Holyoke pump, the movement of the piston rod in any given direction moves the other end of the rocker end in the opposite direction, actuating a loose sleeve on a valve stem on which are 2 collars set in such a manner that there is a certain amount of lost motion. As the piston approaches the end of the stroke, the lost motion on the stem at the opposite end is taken up until the loose sleeve strikes the collar at that end, when the stem is moved until the piston has reached the end of the stroke. The stem being thus moved a small amount, causes the pilot valve attached to it in the chest, to move an equal amount, admitting steam to the proper end of the supplemental valve, which is then moved within its chest a small amount; but in moving, it actuates the main steam valve of the pump, thus reversing the direction of the pump.

In the Dean Bros. simplex pump, there is no lost motion in the valve mechanism beyond that necessary for easy running. The moving piston actuates a carrier arm the opposite end of which travels in the reverse direction to the piston. This end has a slot in it cut radially, and located about in the middle of this slot is an adjustable pin which is attached to the valve stem by a short link. The reversing action in this pump is accomplished by having a short valve and a long travel which produces the same result as a long valve with a short travel accomplished by a certain amount of lost motion at each end of the stroke. By raising the adjustable pin in the radial slot, the stroke of the pump is shortened, and vice versa. G. H. WALLACE.

Induction Motor Trouble

WHILE STARTING under no load, the starting box of an induction motor bearing the following name-plate data: Make, Ft. Wayne; Type S-4; Form D; R.p.m., 1800; Amp., 49; Volts, 220; Hp., 10; Phase, 1; Cycles, 60, has burned out twice. Split phase starting is used.

On account of being a secondhand machine and receiving but little attention, at present the motor is quite dirty and the stator windings appear to be oil soaked.

After the first burn-out, the rotor was cleaned by a local electrician; this, however, did not eliminate a repetition of the first trouble.

I would greatly appreciate any information you may be able to give me regarding the cause. L. R. S.

A. The motor in question is an induction type single-phase machine with 3-phase winding, and using a reactance resistance type starting box. As this motor is secondhand and has formerly been overloaded, you may find that the rotor is unsoldered and has dead points, giving the motor a low starting torque. Possibly the operator has held the starting box in starting position too long and the heavy starting current has burned out the box; this would also have a tendency to overheat the motor. We would suggest that the stator winding be thoroughly cleaned and the rotor resoldered by using either hard or silver solder. The reader should also see that the bearings are not worn excessively so that the rotor will strike the stator. If they are badly worn, they should be replaced with new bearings.

FORT WAYNE ELECTRIC WORKS, L. C. YAPP.

Refrigeration Questions

WHAT IS the boiling point of ammonia? What is a safe temperature at which to store ammonia?

2. What is meant by head pressure and of what use is the head valve? What is the back pressure of an ammonia compression system? R. F. B.

A. The boiling point of ammonia depends on the pressure. We presume you refer to the boiling point at atmospheric pressure. This would be —27 deg. F. You will see, therefore, that it is necessary to store ammonia always under pressure, and at ordinary atmospheric temperature of about 70 deg., the pressure is 114 lb. gage, so that with a reasonably strong container, there will be no difficulty in storing at this temperature.

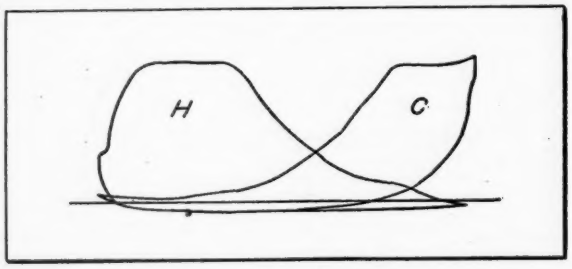
2. The head pressure in an ammonia compression system is the pressure at which the gas leaves the compressor. We are not quite sure what you refer to by the "head valve," but presume this is the expansion valve through which the ammonia gas is allowed to expand from head pressure to back pressure. In expanding in this way, the liquid ammonia takes up a large amount of heat, and thus causes the refrigerating effect. This refrigerating may be used directly in a direct expansion system, where the expansion coils are placed in the room to be refrigerated, or in the ice tank, or it may be used in a brine system where the refrigerating effect is used to cool brine, and this brine is pumped through the coils in the ice tank or in the refrigerating rooms. If this is the valve to which you refer, the valve is used to control the amount of liquid expanding into the expansion coils.

The back pressure is that which is maintained in the expansion coils and the return system to the compressor. The compressor is simply a pump which takes the gas at the low pressure, or back pressure, compresses it to the head pressure, and forces it into the condenser, where the heat is removed by means of water flowing over the condenser pipes, and the ammonia reduced to liquid form. A. L. R.

Unequal Rocker Travel

WHAT EFFECT would it have on the valves of a Corliss engine if the rocker did not vibrate equal distance each side of a plumb line? S.

A. While it is desirable to have the rocker arm (or carrier arm, as it is more frequently called) oscillate equally on both sides of the vertical center line, yet if the arm be long, as is common on some makes of engines, a difference of ½ in. is not noticeable on the valve



RESULT OF WRISTPLATE OVERTRAVEL

adjustment, provided the throw of the wristplate is equal. In fact, sometimes one cannot do otherwise than to throw the carrier arm out a little in order to secure proper throw at the wristplate. With a tandem Corliss engine, it frequently happens that the theoretical perfect adjustment of the rods and connections is dealt a sad blow in order to strike a happy medium where the best all-round conditions prevail.

With the short, stubby type of carrier arm that is used on some of the recent designs of Corliss engines, a slight deviation will affect the steam distribution more or less provided no other adjustments are changed.

Let us assume a single eccentric Corliss engine with a right and left eccentric rod, that this rod for some reason was unscrewed, say, half a turn, and that the threads were 4 to the inch. Then the eccentric rod would be ¼ in. too long and the carrier arm and the wristplate would overtravel towards the head end just that much.

The effect on the steam distribution would be as follows, if it was correct before the accident: Head end late admission, crank end early admission, and greater load on head end. On the exhaust,—head end early release and late compression; crank end, late release and early compression. The accompanying card (exaggerated, of course, to bring out the features) would be about what the indicator would show.

GEO. H. WALLACE.

Compressor Connections

WE HAVE 2 Frick ammonia compressors, one a 12-ton and the other a 6-ton machine.

Can I run both machines by connecting the suction line from the 6-ton machine to 2 of my rooms and let the other operate on the rest of the rooms and have both machines discharge into the same discharge line to the condenser and then take ammonia from the one receiving tank to all of the rooms? Or would it do to run both machines on the same suction and discharge lines? C. W. T.

A. There is no reason why you should not be able to run your ammonia compressors drawing from the same suction, and discharging to the same pipe, if they are speeded so as to give the same final pressure.

You could run them either according to your first suggestion—taking the suction of one machine from one room, and the other from the other room, and discharging both into the same condenser—or you could connect both rooms to the same suction, and discharge both machines into the same high-pressure line.

We believe you would get better control of your rooms if you put one machine on each room, letting them discharge into the same high-pressure line to the condenser, and taking the ammonia for your 2 rooms from the same receiving tank. A. L. R.

Determination of Required Clearance

HOW WOULD you determine the amount of clearance an engine should have? How would you balance the clearance on each end of an engine? G. M. G.

A. Clearance is carefully figured out by the designer of the engine, and after the engine is built, this clearance cannot easily be changed. It is the aim of the designer to make the clearance as small as possible, depending on the type and size of engine. In your case, I presume you wish to balance the clearance for each end as nearly as possible. This can be done as follows:

Find the piston clearance by disconnecting the crosshead from the connecting rod, push the piston against the head, mark on the guide at the end of the crosshead, then push it against the other head and again mark the guide. These marks are the striking points. If the rod is now connected and the crank placed on the center, the distance from the end of the crosshead to the nearest mark will give the piston clearance for that end of the cylinder. With the crank on the other center, the clearance for the other end may be found in the same way. Having found the clearance for each end, you can now adjust the length of the piston rod to make the clearance equal at each end. G. A. T.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Trouble with Air Hoist

I WILL give all the data I can on a Curtis pneumatic ice lift, and would like to have suggestions as to my trouble.

We have a Westinghouse pump that furnishes air to this lift at 75 lb. pressure; the piston is 5-in., using a cup-leather packing, and we have also tried rubber cups instead of the leather. This lift worked all right for about a year, and when we renewed the cup-leather, our trouble started, and it seems to get worse all the time. About 6 months ago we put on a new cylinder, as we found the old one was not true; this did no good, and we have tried about all kinds of oil and grease, all to no avail.

Our air seems to have a lot of moisture in it, and this seems to rust the cylinder, and in putting on new leathers we notice quite a lot of water in the cylinder, sometimes as much as ¼ pint. We have tried leveling the piston, truing it sidewise, etc.

As a rule, these cup-leathers wear out on top, but quite often they wear out on the side. We have used some Dixon's flake graphite in the air-pump, when it would get to groaning a little, and I have known of many engineers using and recommending its use, but the chief here, thinks that it might possibly cake and stick to the sides of the cylinder, and cut out the leathers. We have another crane; but it does not give quite so much trouble, and it gets air from the same pump.

Any information readers can give me in regard to this will be appreciated. A. R.

Reply to Engine Questions

I SUBMIT the following answers to "Some Engine Questions," on page 282 of the March 1 issue:

1. A tandem-compound Corliss engine could have 4 eccentrics if they were of any advantage. They frequently do have 3, one steam and 2 exhaust, giving as delicate adjustment as desired.

2. For a ball joint to run out of line without heating, it must be a perfect sphere and no crankpin would stay so. It is easier to keep bearings on a cylindrical pin with the shaft in line than to use spherical pins and bearings.

3. A ball bearing to stand an alternate push and pull of several tons, would be difficult to build. The friction in the main journals is slight, and even if this could be totally removed, there would still remain the crosshead slides, piston and rod, and valves which could not be made with ball bearing, while the friction thus eliminated would not be worth the price. There is a general misunderstanding on the subject of ball bearings as used in machinery. For a heavy load, a good babbited bearing has, if well oiled, little friction, and it is only in special cases that a ball bearing would be worth while. Try rolling an engine with the crosshead disconnected, and see how easily it turns.

HARRY D. EVERETT.

Leakage Through Tunnel Walls

ON PAGE 282 of the March 1 issue, J. C. H. describes his troubles with a concrete tunnel. I had a similar problem confront and perplex me some years ago, and as J. C. H. explains, the water seeped through the pores of the concrete. The first thing to do is to stop up the pores, which may be done in the following way: Make a solution containing 8¾ lb. of zinc sulphate to a gallon of water and paint the concrete with this mixture. The zinc sulphate will act on the free lime in the concrete, forming insoluble calcium sulphate and zinc hydroxide, which will fill up the minute holes and pores in the concrete.

After painting the concrete with this solution, let it dry about 100 hr., and after thoroughly dry, brush the wall with a wire brush, being sure to have it clean, dry and reasonably free from dust. Give the walls 2 good coats of Smooth-On waterproof cement and finish up with a light coat of hot tar or asphaltum. If this is carefully done, I am sure his troubles will be over.

C. E. ANDERSON.

TO REMEDY his troubles, I would advise J. C. H. to consult the Smooth-On Mfg. Co. This company makes a waterproof cement which, if placed on his tunnel walls to a thickness of about 1 in., will be sufficient to keep the tunnel dry. B. C. WHITE.

WITHOUT the aid of compressed air I am sure there is no way to keep out seepage.

In 1902, I was employed by the Illinois Telephone Co., which built, in 11 months, 12 mi. of tunnel under the downtown streets of Chicago. During that time, we had little trouble with seepage as we carried from 8 to 14 lb. of air pressure, which not only kept it dry but also held up the ground, thus avoiding the use of any timbering.

When the air pressure was removed, however, we had plenty of seepage, even through the 12-in. concrete walls.

I would advise digging a sump and using a good pump, and I am sure the trouble J. C. H. is experiencing would disappear. A. N. RUTLEDGE.

INK SPOTS may be removed from hard wood by a few applications of spirits of nitre. When the surface turns white, clean with a cloth.

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The Proposed Massachussetts License Law

Not content with the present law for the licensing of engineers and firemen, which has seemed to have reasonably good provisions, although, as in most laws, the enforcement of them has not, at all times, been such as to suit either the employers or the engineers, a new law, House Bill No. 1111, has been introduced which has several radical departures in its provisions. In place of the present grades for engineers and firemen, which are first class, second class, third class, fourth class, special portable, steam fire engine, extra first class fireman, first class fireman, and second class fireman, the new law provides for fireman's license and first, second and third class engineer's licenses, the third class being really a special license for one plant only.

In the fireman's license, it is made necessary to have a licensed fireman in control of all boilers, except those of 10 hp. or carrying less than 15 lb. pressure, but the licensed fireman may have control of a boiler plant without the supervision of a licensed engineer, and the law provides that with each licensed person, one unlicensed person may be employed, who, in the presence of and under the personal direction of the licensed person, may operate steam boilers and their appurtenances. Heretofore it has been necessary for a licensed engineer to be in charge of a boiler plant, and a fireman operating the boiler under direction of the engineer.

The only objection which is apparent in the change is to permit a licensed fireman to operate a boiler plant which is used for heating only, where the power is obtained from water power or electric current, the assumption being that the licensed fireman will be a cheaper man than a licensed engineer. We question the wisdom of putting this assumption into practice, even though it might be possible to do so. Knowledge of power plant losses and efficiencies is emphasizing continually the fact that the place where more money is wasted, and can be wasted without anyone knowing it, than at any other point in the plant, is in the boiler furnace, and where coal must be burned for heating, the coal bill is many times bigger than the expense for fireman's wages. An effort to save a few cents a day in wages is likely to result in a larger increase in coal wasted.

We believe that, in his own interest, the owner of the plant should see that the best skill and ability that he has in the power plant are employed in watching the conditions under which the coal is burned, and this apparent effort in the opposite direction is a step backward in progress toward good engineering, and shows the lack of appreciation of power plant problems on the part of those who are proposing this change.

There is a possible other viewpoint that, in making a fireman's license carry the right to have control of the boiler plant, the status of the fireman is being raised in accordance with the importance of his work. If the intent is to give the head fireman, or the boiler room superintendent, as we think he should be called, independent authority, the outcome can only be friction and trouble. Divided authority in a power plant is no better than divided authority in any other organization. Someone must be responsible for results, and have the authority necessary to secure them.

It is evident from the wording of the proposed law, that it is not the intent, however, to give the fireman independent charge in a plant where both boilers and engines are installed, nor to make the fireman superior to the engineer; in fact, tradition and the wider range of knowledge needed by the man in charge of steam, electrical and refrigerating machinery, would make such a reversal of authority practically impossible. Further, the provision for changing from the older form of license to the proposed new form indicates clearly that the fireman's license is supposed to be included in the engineer's license.

So far as the safety of the public is concerned, the first consideration probably needs to be given to the boiler room, as it is the boiler explosion which is more likely to cause disaster to the public at large than any accident which may happen in the engine room. The reduction of requirement, therefore, for the man who is to have charge of this most dangerous part of the steam plant does not seem to be in line with public interest. The simplification of the grading of engineer's licenses may or may not work out advantageously. The first class license as proposed, gives the right to operate any steam engine or engines; the second class, to have charge of and to operate any steam engine not exceeding 150 hp., and to operate larger engines under charge of a first-class engineer; the third class gives the right to have charge of and operate any particular steam engine or engines, and is, therefore, a special license for a given plant. The law does not state that the engineer, in any case, shall have the right to take charge of or to operate a steam boiler, but this is implied in the exchange provision, which says that the holder of a first class engineer's license under the old law shall be entitled to receive a new first class engineer's license and a fireman's license, and similar provisions are made in regard to the other grades. With the exception of the third class license, which is a lumping together of the third, fourth, portable and fire engineer's licenses, there is not much difference in the authority given. The necessity for granting so many special licenses for single plants or engines is likely to result in hardship to both plant owners and engineers, as well as providing opportunity for favoritism and irregularity in the administration of the law. The provision is not sufficiently definite, and leaves too much to administrative discretion.

Other provisions of interest are the basis for horsepower rating of steam boilers, which is given as 3 hp. for each square foot of grate, if the safety valve is set to blow above 25 lb. per sq. in., and 1½ hp. per sq. ft. of grate where the safety valve is set to blow at less than 25 lb. per sq. in. The engine horsepower is determined, for reciprocating engines, on a mean effective pressure of 40 lb. per sq. in. for simple engines, 50 lb. for condensing, and 36 lb. for compound condensing, calculated on the area of the low pressure piston, a variable speed engine being rated at its average speed. A steam turbine is rated at 25 hp. or less, which is the size exempt from operation by licensed engineer, when the external diameter of the steam supply pipe is not over 2½ in., and is to be rated at 150 hp. or less when the external diameter is not over 5 in.

In all cases, the law calls for a practical examination, which is to ascertain whether the applicant has a thorough knowledge of the apparatus which he is to handle and the work he is supposed to do, and the proper precautions for safety and methods to pursue in case of accident.

Heating boilers, engines in private residences, locomotives, farm engines, and those under the jurisdiction of the United States are exempt from the provisions of the law.

To be eligible for first-class examination, an engineer must have a second-class license, or have been in charge of an engine or engines of more than 150 hp. for a period of not less than 2 yr., or must have served as steam engine erector, mechanical engineer or master mechanic of a plant or plants having engines of more than 150 hp. each, for a period of not less than 3 yr.

The engineers of Massachusetts object to this last provision, because it permits a man who has had no practical experience in operating engines to secure a first class license, if he can pass the examination and has served as mechanical engineer or master mechanic in a plant for the required time.

So far as creating a proper spirit of emulation among engineers is concerned, this provision is unfortunate as it enables a man to arrive at the first class engineer's license by other than the path through the boiler and engine room. It is quite conceivable, however, that a man who has served, for instance, a year and a half as an operating engineer on large engines, and has served for an additional year and a half as mechanical engineer or master mechanic in a large plant, may be quite as well equipped with engineering knowledge and experience as the man who has put in the full 2 yr. in the operation of steam machinery, so that, from the standpoint of the interests of the public and of the owner, it does not seem that this provision is a bad one, *if* the other requirement, that the examination shall be of a *practical character* to ascertain that the applicant has *thorough knowledge* of the proper *care* and *safe operation* of steam boilers and their appurtenances is properly enforced.

To be eligible for second class examination, the person must have operated a steam engine or engines for not less than one year, or served as erector, mechanical engineer or master mechanic for not less than 2 yr., and to be eligible for third class examination, the person must file with his application for examination, a written request, signed by the owner or user of the engine or engines of which he is to have charge, and he will then be examined on the care and operation of this particular installation.

For fireman's license, a man must have been employed as fireman for not less than one year, which assumes that he must have been working with a licensed fireman for that period of time, or else must have been working under the charge of a licensed engineer.

One feature which might, in the case of the third class licenses work a hardship, is the provision that a period of 90 days shall elapse between examinations, except in the case of an appeal from the decision of the examiner. It is pointed out by some of the engineers, that if a man secured a third class license for a given plant, and through some misfortune should lose that position after license had been granted him, he must wait 90 days before he can be re-examined for another

plant. Presumably this point was not considered by those who framed the law, and it is probable that an amendment on this point, to take care of the condition pointed out, would readily be embodied. Other provisions for the revocation of a license, and for appeal from decision are such as are commonly embodied in license laws.

So far as present licenses are concerned, the law provides that such licenses shall continue in force until suspended or revoked for incompetence or untrustworthiness of the licensee. Those who already have licenses are, therefore, protected, but, of course, if a man desired to change the grade of his license, he would be compelled, if the law passes, to take out the higher grade under the provisions of the new law. While not a close index, the provisions for exchange for those wishing to do so are interesting as showing what, in the minds of the framers of the law, constituted the relative equivalents. The holder of a first class engineer's license shall be entitled to receive a new first class engineer's license and fireman's license. In place of the second class will be granted a new second class and a fireman's; in place of the present third class, a new third class and fireman's; in place of the present fourth class, a new fireman's license; in place of the present portable, a new fireman's license; in place of the steam fire engineer's, a new fireman's license; in place of the extra first class fireman's, a new fireman's; in place of the first class fireman's, a new fireman's, and in place of the second class fireman's, a new fireman's, if the holder has acted as fireman for at least one year.

It is evident that this exchange will tend to a certain loss of standing and progress on the part of holders of the present third class, fourth class, portable, steam fire engineer's, extra first class fireman's, and first class fireman's licenses, since the third class engineer is reduced to a special license, and all the others are put on the same basis as the holder of a second class fireman's license who has worked one year at firing.

The construction of the provisions leads to a feeling that the proposed law has been framed more with the ideas of a few employers of engineers and firemen in mind than with any idea of looking out for public safety or the welfare of the power plants.

News Notes

THE TERRY STEAM TURBINE CO., Hartford, Conn., announces that its Chicago office will hereafter be in charge of A. W. de Revere, and located in the Peoples Gas Bldg. The company has also opened an office in the Michigan Trust Bldg., Grand Rapids, Mich., in charge of A. L. Searles, to cover the southern peninsula of Michigan.

MARCH 9 TO 11 the 7th annual meeting of the Illinois Section Water Works Association was held at the University of Illinois, Urbana, Ill., with president H. M. Ely in the chair. Many papers were presented during the 3 days' session, among those of especial interest to power plant men being the following:

"Design and Operation of Intermittently Operated Water Purification Plants," by E. B. Black; "The New Harrisburg, Ill., Filter Plant," by L. F. Payne and Glen W. Bass; "Soft Water," by C. L. Kennicott; "New Filtration Plant at De Kalb, Ill.," by Harry Ruthrauff; "Filtration Plant at Quincy, Ill.," by W. K. Gelston; "Treatment of Water for Locomotive Use," by W. A. Pownall; "State Regulation of Municipally Owned Plants," by C. M. Larson; "Application of Theories of Regulation to the Management of Utilities," by D. A. Graham.

PROFESSOR C. R. RICHARDS, of the Department of Mechanical Engineering of the University of Illinois, has designed a hydraulic absorption dynamometer, several of which have been built in the college shops. One is to be connected to the new 60-hp. 6-cylinder Peerless automobile engine in the Mechanical Engineering Laboratory.

The Engineering Experiment Station of the University of Illinois is conducting tests of various building materials to determine their coefficients of heat transmission. The work is being done by L. C. Lichty, Research Fellow, under the direction of Professor L. A. Harding of the Department of Mechanical Engineering. The results of the tests are expected to be of especial value to heating and ventilating engineers.

Apparatus for testing steam nozzles has just been installed in the Mechanical Engineering Laboratory at the University.

Professor O. A. Leutwiler and Messrs. H. W. Waterfall and A. B. Domonoske of the Department of Mechanical Engineering are conducting an interesting series of tests on a friction clutch for the purpose of determining the relative value of different commercial materials used for clutch linings.

U. S. CIVIL SERVICE COMMISSION announces an examination, April 20, 1915, for gas waste engineer, to fill a vacancy in the Bureau of Mines, Dept. of the Interior, for service in the field, at a salary ranging from $2400 to $3600 a year. The duties of this position will be to investigate the production, transportation, distribution, and utilization of natural gas, with particular reference to the waste of natural gas and the suggestion of corrective methods that will eliminate this waste. It is desired to procure the services of persons with a broad technical and practical engineering experience in natural gas and related petroleum industries. The following subjects will have the relative weights indicated: Education and experience, 80; publications or reports, 20. Graduation in mechanical engineering from a college or university of recognized standing, and at least 5 yr. of responsible practical experience covering the development, production, transportation, distribution, and utilization of natural gas; or for persons lacking the engineering degree at least 8 yr. of such experience, is a prerequisite for consideration. Professional reports may be submitted in lieu of or in addition to publications. Applicants must have reached their thirtieth but not their fiftieth birthday on the date of the examination. Apply for Forms 304 and 2095, stating the title, Gas Waste Engineer (Male).

OUTDOOR METERING OUTFITS are the subject of General Electric Co.'s Bulletin No. 46,251, describing outfits designed for power companies operating high-voltage transmission lines where it is not advisable to build a complete substation.

Charles A. Schieren

THROUGH the death of Charles A. Schieren the leather and belting industry has lost one of its most influential leaders. By a sad coincidence the death of Mrs. Schieren occurred in less than 24 hr. after that of her husband with whom she had spent 50 yr. of married life.

About 2 yr. ago Mr. Schieren was attacked with stomach trouble and attendant complications. His condition became so serious that Feb. 2, 1914, an operation was performed. He went to his country home at Islip, L. I., after the operation, and spent a long time recuperating. His growing ill health had previously caused him to retire from practically all business affairs. January 4 of this year he went to Atlanta, Ga., in the hope that the milder climate of the south might benefit him, but at the end of 6 weeks his condition became such that it was deemed advisable to return to his Brooklyn home at once. Mr. Schieren gradually grew worse and finally took to his bed. Pneumonia developed in an acute form, and he died March 10.

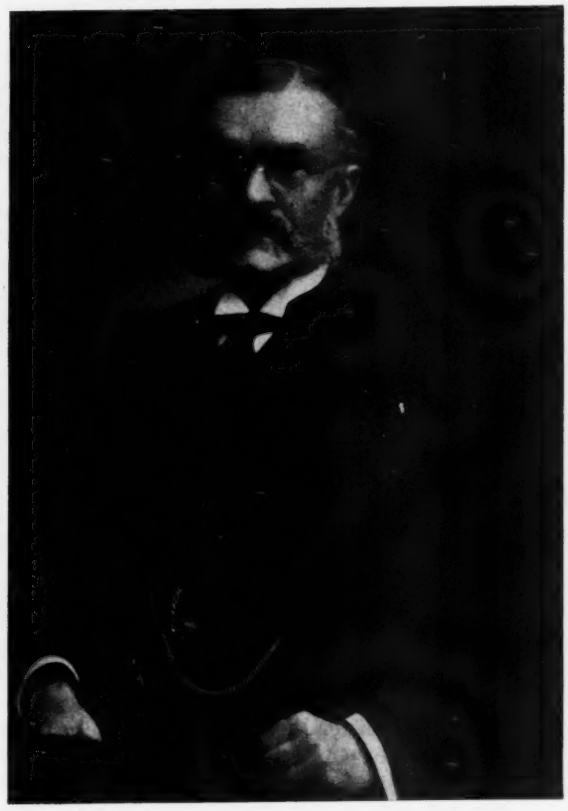
Charles A. Schieren came to this country with his parents in 1856. At first he was engaged in the cigar trade with his father, but he took a dislike to it and in 1864 obtained a position as salesman in the leather belting house of Philip F. Pasquay, 25 Spruce street. By close application and energy he soon acquainted himself with the business, especially the making of leather belting, so that when his employer died, Mr. Schieren was selected as manager of the estate. The business was sold to Heim & Zimmerman, and with them he remained until April, 1868, when he founded the present house at No. 92 Gold street with the moderate savings of his 4 yrs.' salary. He built up in a comparatively short time one of the leading leather belting establishments of this country. He continued alone until 1882 when he entered into co-partnership with Jacob R. Stine. The latter retired at the expiration of the term in 1887, and in 1888, F. A. M. Burrell was admitted. Mr. Burrell began as office boy in 1877 and worked his way up to the position of chief clerk and next to partner. Mr. Burrell's interest has since been purchased by the company.

The business is now controlled by the Schieren family, having been incorporated as the Charles A. Schieren Co., with Charles A. Schieren, Jr., as president; G. Arthur Schieren, vice-president, and Harrie V. Schieren, secretary and treasurer. The firm does an extensive business over the entire civilized world, and has branches in practically every city of prominence. The tannery is located at Bristol, Tenn., and is one of the largest of its kind in the country.

Mr. Schieren had for many years taken an active interest in political, religious and charitable affairs rendering generously financial as well as personal aid. He was active in the Brooklyn Young Men's Christian Association, having been a director and member of the Advisory Board of that association and was also interested in the work of the Young Women's Christian Association.

For several years Mr. Schieren was vice-president of the Hide & Leather Bank of New York, a member of the New York Chamber of Commerce, trustee of the Germania Savings Bank of Brooklyn and the Brooklyn Trust Company, and director of the Nassau National Bank of Brooklyn. He was a member of the Hamilton and Germania Clubs, Brooklyn, and the Fulton, Down Town, Union League and other clubs in Manhattan. Mr. Schieren was also vice-president of the Brooklyn Institute of Arts and Sciences. Several years ago he made a gift of $50,000 to the Lutheran Theological Seminary, Philadelphia, for the creation of professorship there.

Mr. Schieren was elected mayor of the old city of Brooklyn in 1893, in a reform movement, by a big plurality. The administration of Mayor Schieren was marked by many important civic improvements.



Mrs. Schieren had suffered from heart disease for many years. She nursed her husband until the sixth of March, when she was stricken with pneumonia. At the time, Mr. Schieren was told of his wife's illness but not of her serious condition, and Mrs. Schieren was not told of the dangerous condition of her husband. She survived Mr. Schieren just about 24 hr., and passed away Thursday morning at her home, 405 Clinton Ave., Brooklyn, without knowledge of her husband's death.

A double funeral was held Saturday, March 13. Mrs. Schieren was born in Manhattan, 74 yr. ago, and was the daughter of George W. Bramm and Louise M. Bramm. For many years Mrs. Schieren had taken an active part in church and charity work in Brooklyn and was interested in various societies for improving the condition of the poor, etc.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Fuel Oil Burning

IN order to utilize the heat value of fuel oil, it must be changed from a liquid into a spray consisting of fine particles of oil floating in and surrounded by air. In this condition, it can be easily ignited and the value of the oil as a fuel will be directly proportional to the fineness of the spray. Each particle of oil must be supplied with the necessary amount of air so that a complete union may result when the temperature is raised to the ignition point, the resulting product being carbon dioxide, water and other oxides, if sulphur is present.

The breaking up of the oil may be accomplished by compressed air, at various pressures from 30 to 100 lb. Burners constructed on this principle are known as "high pressure burners," but atomization can be accomplished also by mechanical means and by low pressure

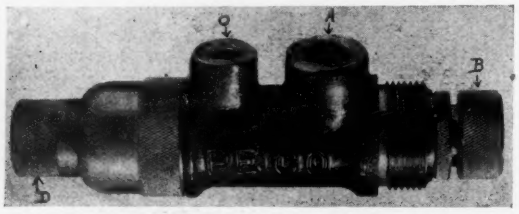


FIG. 1. PECO OIL BURNER

air, such as a fan blast of varying pressures up to 5 lb.

The compressed air may be regulated in a properly constructed oil burner so that the minimum amount is used and for atomizing only, while the balance of the air necessary for complete combustion is furnished by induction from the atmosphere or by a fan blast if desired.

Figure 1 is a cut of the No. 2 Peco patent oil burner, which has been designed to meet every requirement of a high pressure burner, by the Production Engineering Co.

This burner can be operated with any oil pressure from 0 to 100 lb., and under any compressed air or steam pressure from 30 to 100 lb. It will atomize from 2 to 70 gal. of oil per hour. The compressed air connection is made at A and the amount of air used is regulated by screwing nozzle B in or out as desired. The oil connection is made at O and the amount of oil being atomized is regulated by screwing the projecting spindle, D, either in or out, as less or more oil is wanted. Should the oil hole inside of nozzle B become clogged with sand or some other obstruction, it may be instantly removed by pressing D forward quickly and releasing. This can be done without interfering with the action of the burner in any way and the oil setting will always be maintained, as the plunger D is always brought back to its position by means of a spring. After nozzle B is set to a proper position for atomizing, it can be clamped by means of the jamb nut.

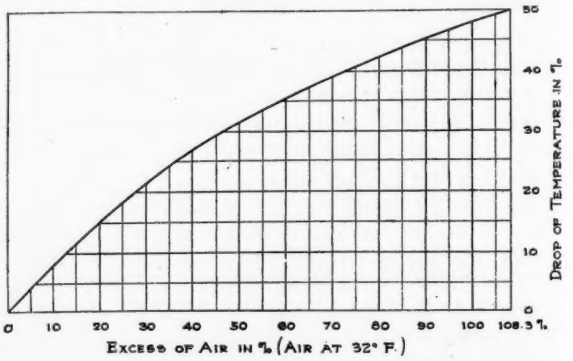


FIG. 2. INFLUENCE OF EXCESS OF AIR ON FURNACE TEMPERATURE

A great waste of fuel will result if the proper mixture of air and oil is not secured and constantly maintained. If too little air is admitted to the furnace, more or less heavy smoke will be produced, but if too much air is admitted, it cannot be detected by the eye,

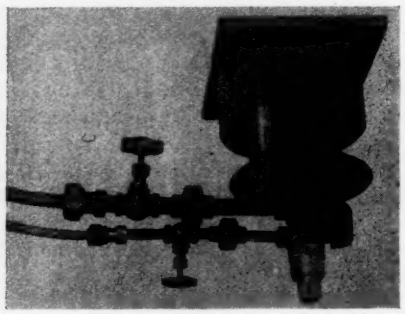


FIG. 3. DEVICE FOR REGULATING AIR SUPPLY

but there will be a corresponding loss in the heating value of the fuel. This is plainly seen by an inspection of the diagram showing the drop in temperature which takes place from an excess of air.

Every pound of oil requires theoretically from 14.3 to 14.6 lb. of air for its complete combustion, depending on whether it is a light, medium or heavy oil.

It is, therefore, a matter of great importance that the exact amount of air for combustion be admitted to the furnace along with the oil spray so that the maximum heat value in the oil may be obtained.

The Production Engineering Co. has designed a device to accomplish this purpose, which can be adjusted so that not over 2 per cent of exeess air is admitted to the combustion chamber if it is otherwise tight.

The burner is mounted as shown in the cut, the connections to the oil and air lines being made by short lengths of high pressure, flexible steel piping.

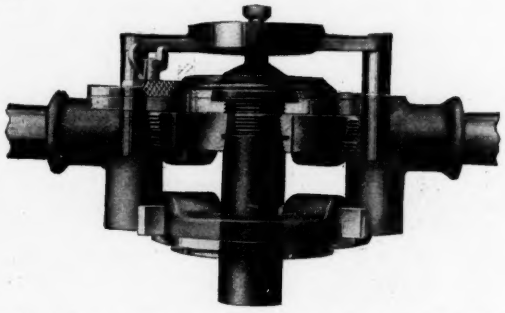
After the burner has been lighted and put into operation, the shield in which it is mounted is moved in until smoke appears in the furnace, and is then moved backwards until it just disappears, at which point the inlet may be fixed by means of the set screw. When set as above, just enough air is induced through the curved inlet by the oil spray itself (acting as an injector) just to burn the oil, and no further setting is necessary unless the conditions are changed. At the end of the run when the furnace is shut down, the burner may be swung out of the direct refracted heat from the inside of the furnace and be protected from carbonizing.

The swinging movement may be accomplished without disturbing the burner in any way as the flexible metallic hose will adapt itself to the new position without trouble.

Beaver Cross Bar Die Stock

DIES used in this stock are made in 2 sections. The lower section does the rough starting with teeth especially formed for this purpose. During starting, the die remains stationary; after the upper section begins to cut, this lower die is gradually withdrawn from the pipe until, as shown in the cut, it no longer touches.

The upper die is a narrow, receding die, and constantly opens as the thread is being cut, producing a standard thread by continually cutting out less metal. These dies have the further advantage of following the partial threads cut by the first section, which reduces labor and insures correct thread pitch without a leader screw.



CROSS BAR DIE STOCK CUT OPEN TO SHOW CONSTRUCTION AND METHOD OF OPERATION

Principle of operation of this die stock is as follows: A swiveled plug extends between the dies down to the bottom of the upper section. The pipe is started and threaded as usual; when the work of the lower stationary die is completed, the pipe end comes in contact with the swiveled plug, raising it as the second set of dies cut the thread. Raising the plug lifts the side posts, turns the engaged die cam, and gradually opens the dies so as to produce the proper taper. When the thread is completed, the dies are released. No backing off is necessary.

The dies are set by the handle shown, and the pipe threaded without attention by the operator. To cut another thread the cross bar is simply pushed down, thereby resetting the tool.

To allow chips to get away and for free oiling facilities, the body of the tool is made of practically one piece with wide openings.

A universal guide centers all sizes, of from ¼ to 1¼ in. The tool is regularly furnished with double ended reversible dies ½ to 1¼ in.; extra ¼ by ⅝-in. dies, and all sizes, either right or left-hand, can be supplied.

Further details are given in a new booklet issued by The Borden Co., of Warren, Ohio.

McIntosh & Seymour Exhibit

LARGEST and most powerful among the oil engines exhibited in the Palace of Machinery is the 525 b.hp. Diesel type set, now on the space occupied by the McIntosh & Seymour Corporation, of Auburn, N. Y. This is a fitting honor for a thoroughly American and long-established company, which has gained world-wide renown in the domain of steam engines.

During the course of its history, this firm has built machinery aggregating more than 1,500,000 hp. It has constructed some of the biggest engines in the world, the size having been limited only by the restrictions of shipment and transport. Three mammoth engines of 5000 kw. capacity each, built by the Auburn firm, are installed in the Redondo Central Station of the Pacific Light & Power Co., and other powerful sets from the same works can be seen in notable power plants all over the United States.

The single-cylinder horizontal 100-kw. steam unit representing the McIntosh & Seymour Corporation in the Palace of Machinery is a dwarf in size, but its economy and efficiency are noteworthy. Two reasons have been responsible for the selection of such a relatively small unit to typify and illustrate this firm's steam engine construction. In the first place, fashions have changed, and the mammoth reciprocating steam engine is no longer demanded. Secondly, the scope for the steam engine in California is destined to become less now than the Diesel type engine, which burns the fuel oil directly, can supplant it with greater satisfaction and to better advantage.

Of the 2 Diesel-type engines which are being installed by the McIntosh & Seymour Corporation, the larger set, of 525 hp. capacity, 4 cylinders, 165 r.p.m., will be shown in operation, using the fuel oil supplied at the header in the Machinery Palace. At the price of 92 cents a barrel of 42 gal., this fuel will give about 850 b.hp.-hr., or, say, 525 kw.-hr., at a cost of $1.

The smaller Diesel-type engine on the space occupied by the McIntosh & Seymour Corporation is a 4-cylinder set of 280 b.hp. capacity, designed to turn at 200 r.p.m. In character, it is distinguished from the larger set chiefly by its box-frame and by the greater compactness due to the higher running speed.

Application of Electro-magnet to Surgery

REMOVAL of pieces of shrapnel, steel-jacketed bullets, etc., by the use of powerful electro-magnets in hospitals abroad has been acclaimed by many newspapers as the latest application of science to surgery. It is interesting to note that the Westinghouse Electric & Mfg. Co. has installed in the Relief Department of its East Pittsburgh Works a magnet for removing metal imbedded in the flesh, which is one of the most powerful in the world.

The magnet is mounted on a box containing the resister, which is used to regulate the amount of current flowing through the coils. It requires 4000 w. for its

POWERFUL ELECTRO-MAGNET REMOVING METAL IMBEDDED IN FLESH

operation, or enough power to supply 100 32-candlepower Mazda lamps. It is designed for operation on 70 v., and as the circuit from which it draws current is used for testing purposes and ranges from 70 to 120 v., a resister is necessary.

It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. Previous to the installation of a magnet the only means of removal was by probing, a method which is as uncertain as it is painful. Since this machine was put in operation it is a simple proceeding to extract such particles. The portion of the body in which the foreign particle is imbedded is placed near the pole tip of the magnet, the switch closed, and the magnet does the rest. The pole is removable, a number of different shapes being supplied for various classes of work.

It is common for flying bits of metal to lodge in the eye. Should they strike with force enough to become imbedded, the removal, without the aid of a powerful magnet, is apt to be difficult as well as painful. The protecting coating of the eye must be cut, and there is danger that, instead of removing the particle, it may be pushed farther into the eye. When the foreign body is once within the eyeball, it is properly a case for the specialist.

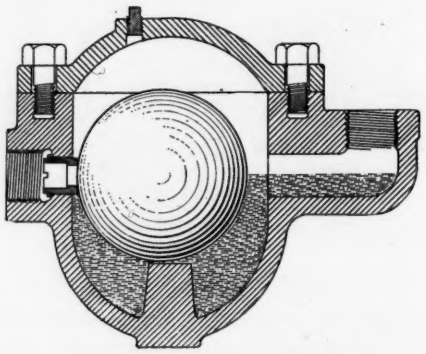
Steel workers frequently have their hands punctured with minute pieces of metal, which become imbedded under the calloused skin, and which, allowed to remain, cause the wound to become infected. The use of a powerful magnet insures the removal of all traces of iron from wounds in the hand, or any other part of the body. Some remarkably small pieces have been extricated in this way, one recently recovered being not 1/12 of the thickness of a delicate needle.

Dr. C. A. Lauffer, Medical Director of the Westinghouse Electric & Mfg. Co., relates a number of instances in which the magnet has proved invaluable. Among these is the rather amusing case of a workman who attempted to drill one of his own teeth. The drill broke off about ½ in. from the end and remained in the cavity, and it seemed as if the only way to remove the drill would be to pull the tooth. A special extension was made, however, and fitted to the magnet pole. As soon as the extension was brought in contact with the drill and the current switched on, the drill was drawn out.

The Brown Steam Trap

SIMPLICITY of construction is an important thing in steam traps and is but one of the important features claimed for the Brown Steam Trap, which, as shown in the accompanying illustration, consists of a cast-iron body and cover and nonattached floating ball constructed of heavy metal with a copper deposit and finally nickel-plated and polished.

It is stated that when condensate enters the trap through the inlet, the ball floats, opening the discharge orifice and permits a constant discharge of water and air without loss of steam.



CROSS-SECTIONAL VIEW OF THE BROWN STEAM TRAP

The floating ball, made to withstand a pressure of 300 lb. and being nonattached, is without any lever strain and as a result will not tend to leak or collapse. It adapts itself to a new seat every time the trap discharges and is always kept clean. The valve seat is made of bronze.

This trap, which is handled by the D. G. C. Trap & Valve Co., Inc., New York, is recommended for use on heating systems, blower coils, steam piping drips, steam separators, all types of manufacturing apparatus and wherever it is necessary to remove water from steam.

Catalog Notes

BULLETINS FROM THE Bureau of Mines, Department of Interior, are now ready: No. 84, of 92 pages, on "Metallurgical Smoke," by Charles H. Fulton; No. 85, on "Analyses of Mine and Car Samples of Coal Collected in the Fiscal Years 1911 to 1913," 444 pages, by A. C. Fieldner, H. I. Smith, A. H. Fay and Samuel Sanford; also, Technical Paper 80, on "Hand-Firing Soft Coal Under Power Plant Boilers," 83 pages, by Henry Kreisinger, and Miners' Circular 21, "What a Miner Can Do to Prevent Explosions of Gas and of Coal Dust," 24 pages, by G. S. Rice. A limited supply of these publications is available for free distribution to those who have satisfactory reason for desiring them. Application should be addressed to the Director of the Bureau of Mines, Washington, D. C.

DE LAVAL STEAM TURBINES, velocity-stage type, in sizes from 1 to 600 hp., are described and illustrated in Catalog C from De Laval Steam Turbine Co., Trenton, N. J.

Catalog D, from that company, deals with De Laval steam turbines, multi-stage type, suitable for direct connection to high speed machinery, or, combined with De Laval reduction gear, for the driving of slow and moderate speed machinery.

DESCRIPTIVE LEAFLET NO. 3767, issued by the Westinghouse Electric & Mfg. Co., covers magnet switch starters for alternating-current motors with squirrel cage and slip-ring rotors. This type of switch, which has become quite popular for industrial applications, is thoroughly described and illustrated in the leaflet.

BULLETIN H, recently published by Elliott Co., 6910 Susquehanna St., Pittsburgh, Pa., illustrates a number of varieties of the company's alarm water columns.

THE GENERAL ELECTRIC CO. has just issued an attractive and profusely illustrated bulletin, No. 44,003. devoted to Modern Electric Railway Apparatus. The bulletin is contained in a colored cover of artistic design, and describes the Curtis steam turbine for railway service, railway generator, transformers, switchboards, synchronous converters, motor-generator sets, G-E ventilated railway motors, electric locomotives, and contains illustrations of the G-E locomotives, in use at the locks of the Panama Canal.

Bulletin No. 46,018 describes the company's portable voltmeter, known as Type P-8. This is an unusually small instrument inclosed in a mahogany case, and suitable for use on both alternating and direct current. The bulletin describes the instrument in considerable detail, and includes a reproduction of the scale in actual size.

STOW MFG. CO., Binghamton, N. Y., is sending out Bulletin No. 54, describing several tools recently added to the company's list, including Stow motor-driven General Utility tool, particularly adapted to screwdriver work as well as die sinking, buffing, drilling and grinding.

THE NELSON VALVE CO., of Chestnut Hill, Philadelphia, has issued a revised edition of its 12-page folder entitled "Double Disc vs. Solid Wedge." It contains an interesting history of the development of the gate valve. Copies will be mailed on request.

CATALOG NO. 17 from Reeves-Cubberley Engine Co., Trenton, N. J., deals with single-valve side and center-crank horizontal engines, 4-valve nonreleasing gear Corliss engines, vertical cross-compound engines and vertical single-valve engines.

DRY STEAM is the title of Catalog No. 10 relating to the Tracy steam purifier, manufactured by The Tracy Engineering Co., of San Francisco.

OHIO BRASS GATE VALVES for 100 and 125 lb. pressure are illustrated in a folder just issued by The Ohio Brass Co., Mansfield, O.

Trade Notes

SCHAEFFER & BUDENBERG Mfg. Co., of Brooklyn, N. Y., has completed and is now occupying its new plant at Berry and So. 5th Sts. This building is a concrete structure of modern type and design, having 7 floors, with a total of 70,000 sq. ft.

Careful planning of the various departments and of the removal of elaborate chemical and testing apparatus has made possible entire freedom from delay in putting the new plant in operation. The feature of the plant is a large exhibition room in the main office, showing the complete line of the instruments and testing apparatus made by the concern. Here visitors are always welcome, and will be able to learn much of value in the study of the apparatus, which includes thermometers and gages, both indicating and recording, counters, time recorders, pyrometers, indicators and calorimeters.

SARCO ENGINEERING CO., of New York, announces that its sales of Sarco steam traps, Sarco vacuum valves, and Sarco temperature regulators have shown substantial continued increases during the past half year, despite the influence of the European war, and the company is moving its offices to the new South Ferry Bldg., No. 1 State St., New York.

SPRAGUE ELECTRIC WORKS of General Electric Co. has recently opened a branch sales office in Cleveland, Ohio. It will be in charge of Frank H. Hill, Manager, who also has charge of the Pittsburgh Office. The Cleveland Office will be located in the Illuminating Bldg.

THE E. KEELER CO., of Williamsport, Pa., was awarded a contract for 18 water-tube boilers by the Illinois State Board of Control. Nine of these are 300-hp. and 9 are 400-hp., with automatic stokers.

H. A. ROGERS CO., 87 Walker St., New York, has just been appointed New York agent for Westcott chucks, and is prepared to fill orders at once.

THE HOPPES MFG. CO., Springfield, Ohio, reports the recent sale of 2 1,000,000-lb. per hr. Hoppes V-Notch recording meters to the West Penn Traction Co., Pittsburgh, Pa. This is reported to be the largest installation of feed water metering equipment in the world and will be operated in connection with Hoppes feed water heaters.

SPRAY MFG. CO. announces that it has started in business at 201 Devonshire St., Boston, Mass., with New York and Chicago branches.

The company is making a specialty of spray cooling ponds, spray air washers, gas scrubbers, and various engineering applications of spray devices.

A. G. Eneas, who formerly organized and developed the Spray Engineering Co., has severed his connection with that company, and has taken charge of the engineering department of Spray Mfg. Co.

THE SOUTHWARK FOUNDRY & MACHINE CO. of Philadelphia, Pa., has secured the exclusive United States License to manufacture the Harris Valveless Engine, Diesel principle, which will hereafter be known as the Southwark-Harris Valveless Engine. This engine will be built in sizes ranging from 75 to 1000 b.hp. for both marine and stationary service.

L. B. Harris, inventor of the Harris Valveless Engine, and J. P. Johnston, who has been interested in and connected with the development of the Harris Valveless Engine, will be associated with this company, the former as consulting engineer and naval architect, while the latter will have charge of oil engine sales.

THE DISTINCTIVE FEATURES of the concentrated filament Mazda lamps of high wattages have proved so popular that the Edison Lamp Works of the General Electric Co. has developed vacuum Mazda lamps of similar appearance in the 25, 40 and 60-w. sizes. This concentrated filament construction gives greater vertical distribution of light than the regular Mazda lamps of corresponding wattages. The new lamps will, therefore, be employed where a natural downward distribution of light is required. They can be used in existing sockets and fixtures.

These lamps will be made in the same sized bulbs as the corresponding regular Mazda lamps, will have the same spherical watts per candlepower efficiency and will have a rated average life of 600 hr.

THE MANATI SUGAR CO., in the Province of Oriente, Cuba, with offices in New York City, has recently placed an order with the Westinghouse Electric & Mfg. Co., East Pittsburgh, for electric motors to drive all of its machinery in its new mill, with the exception of the engine-driven rolls. This order covers a total of 32 alternating-current motors, having a total capacity of 1042 hp. All of the auxiliaries in this next extension of the Manati Sugar Co. will be motor driven, these auxiliaries including cane and bagasse conveyors, centrifugal pumps, crystallizers, agitators, etc. All of the new material will be in operation for the 1915-1916 grinding, and the electrical equipment will be delivered in time for this operation.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

SEMI-MONTHLY

Subscription price in advance in the United States. Mexico or united possessions, $1.00 a year.

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Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00
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Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 4-1-1

POSITION WANTED—By I. C. S. Student as oiler in a steam electrical plant where there is a chance for advancement. Some experience with steam. Age 27. Address Frank Knapp, 404 So. Fifth St., St. Joseph, Mo. 4-1-1

POSITION WANTED—As chief engineer in a small or medium sized plant. Twelve years' practical and technical experience in operation and maintenance of steam, electric refrigerating, pumping and condensing equipment. First class license. Married; age 30. Employed. Address Practical Engineer, Box 392, Chicago, Ill. 4-1-1

POSTION WANTED—As assistant engineer; experienced; I. C. S. student; best references; strictly sober; hold first-class license; will consider small salary if advanced as merited. Address Robert Pieper, Blooming Prairie, Minn. 4-1-1

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 4-1-1

POSITION WANTED—By engineer with 10 yr. experience on Corliss and slide-valve engines, horizontal and vertical water tube boilers. Age 40 yr. Address Ed Larson, Aetna, Ind. 4-1-1

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 4-1-1

Wanted

WANTED—Residence subscription agent in the following cities: Atlanta, Ga., Baltimore, Md., Cincinnati, Cleveland and Columbus, Ohio, Denver Colo., Detroit, Mich., Kansas City, Mo., Los Angeles, Calif., Louisville, Ky., Minneapolis, Minn., Newark, N. J., New Orleans, La., Philadelphia, Pa., Portland, Ore., St. Louis, Mo., St. Paul, Minn., San Francisco, Calif., Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, subscription Department, Chicago, Ill. tf.

WANTED—Representatives to cover territory more thoroughly. Boiler room necessities. Liberal commissions. Old established house. Apply by letter. H. F. Maurel, 534 W. 22nd St., New York City. 4-1-3

WANTED—Agents to sell my Graduated Calipers, Pocket Levels, etc. Liberal commission. Ernst G. Smith, Tampa, Fla. 2-1-16

Help Wanted

WANTED—Sales Engineer. Successful concern, established eighteen years, highest standing in its line in the United States, wants a Sales Engineer. Only first-class salesmen having had experience in engineer lines considered. Our product a necessity in every boiler plant. Price averages $250 per boiler. Sold on absolute guarantee. Exclusive territory allotted. Cash advances on trial orders will finance you if you have the ability. Positively give details about yourself in first letter. All correspondence held strictly confidential. Address Box 391, Practical Engineer, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FOR SALE—Machinery. All sizes new and second-hand Pulleys, Belting, Shafting, Hangers, Couplings, Pillow Blocks, Collars, etc. Passman Bros., 28 and 30 So. Green St., Chicago, Ill. 3-15-16

FOR SALE—Specials: 10x24 Allis Corliss engine, overhauled, $375. Three 72 in. by 18 ft. HRT boilers, 150 lb. steam pressure, 2 yr. service, $400 each. 500-hp. Heine water-tube boiler, 6 yr. service, 150 lb. steam pressure, $1675. 75-kw. Northern 230-volt generator, direct-connected Erie Ball engine with switchboard, $1000. Duzets & Son, 50 Church St., New York. tf.

FOR SALE—Grobet Swiss Files are the standard of excellence in files, and have been for over 100 yr. We send, post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 3-1-1

FOR SALE—20x42-in., 82 r.p.m. Griffith Wedge Corliss Engine; 175 kw. W. E. Co. Generator, 3 wire 250-125 volts, 230 r.p.m., belt connected, with switchboard; two 300 hp. Otis Heaters No. 8, 25x96 in. Above equipment in excellent condition. Removal to larger plant reason for sale. Can be seen by appointment. Address, Chief Engineer, 4th and Webster Aves., Long Island City, New York. 4-1-1

CARR VENTILATED FURNACE ARCH for all types of boilers and furnaces, gives 100 to 400 per cent greater service than any other kind. Write for information, giving number and kind of boilers and furnaces. Elmer E. Carr, 231 Insurance Exchange Bldg., Chicago, Ill. 3-1-3

FOR SALE—Steam Hammer, 750-lb. Bement Niles; excellent condition; will sacrifice to move quick. Have large stock machinery of all kinds. Send us your inquiries. Zelnicker Supply Co., St. Louis, Mo. tf.

FOR SALE—Boiler, Engine, Heater, Pump, 42 kw, 125 volt d.c. Generator with switchboard and some meters; all in good shape. Must be sold in 30 days. This is a good bargain. A. McAlpin, Lincoln, Neb. 4-1-1

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Micellaneous

FREE GASKET INFORMATION—Know why an annealed copper gasket is stronger and better than an unannealed gasket. Write the Akron Metallic Gasket Co., 152 N. Union St., manufacturers of Akron Corrugated Copper Gaskets, Akron Steel Gaskets, Akron Lead Gaskets, Akron Copper Asbestos Filled Gaskets, Akron Copper Asbestos Ribbed Gaskets, Akron Steel Asbestos Gaskets for boilers, Rubber Gaskets and Compressed Asbestos Gaskets 4-1-2

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

SPRING MEDICINE

Few of us will forget the bitter doses, those mysterious home-prescribed concoctions that we were forced to swallow in our younger days at this time of the year.

How the various tongues of the household were stretched and almost loosened from their moorings as they were placed on exhibition before the critical eyes of the mother of the brood who energetically and forcefully emphasized the dangers of the winter's accumulation of disease germs and whose principal remedy, brimstone and treacle, was the panacea for all spring ills.

As spring has again been ushered in officially by wild geese and weather prophets and the younger generation is no doubt getting its dose of spring medicine to prevent physical decline, we have cause to reflect upon the sure remedy for business decline. It is one, however, that is effective all the year 'round—spring, summer, fall or winter.

We speak of advertising!

Every advertisement tends to promote a congenial relationship between advertiser and reader. It fraternizes them. This accounts for the noticeable spirit of friendliness at conventions. The man in need of any commodity represented there and which has been advertised, knows something about it and therefore is not backward in talking of it. He has followed the progress and results of the product through the advertising page, for it is generally conceded that the success of any product is shown in its advertising.

We recall how a successful valve reseating machine advertised extensively for a number of years attracted so much attention at the last National Engineers Convention that it took five representatives from eight in the morning until ten at night to answer questions and to demonstrate its operation. Engineers knew about it and wanted to see it. On the other hand, had it not been advertised their interest would have been aroused to much less extent.

"I hate that man" said one friend to another recently. "Do you know him?" "No, I don't," "Well, then," replied his friend, "If you knew him you would not hate him."

In a like manner the unadvertised product is subjected to the same criticism.

It must be known to overcome the possible prejudice against it.

And when the standard is once set it must be maintained. As long as the product is advertised it is considered up to standard. The consumer knows this—the producer should realize this.

No product can be successfully marketed, if the advertiser is lacking in stamina as was the Mississippi steam boat Abe Lincoln tells about that had such a big whistle and such a small boiler that every time the whistle was blown the engine stopped. It is the persistence in making the product known that achieves results.

Furthermore, the strongest foe of dishonest advertising is advertising, itself. He who advertises brings his product under the penetrating rays of the searchlight of public attention, subjecting it to close scrutiny and keen analysis.

Deception therefore cannot permanently endure. Advertisers know that one false statement will be harmful to every other statement they make, just as one counterfeit dollar throws suspicion on all genuine dollars.

There is a similarity between the disease germs of the human system and the deceit germs of the business system. As brimstone and treacle is the old-fashioned spring medicine for driving out the impurities—those disease germs that tear down the tissues which build up the flesh and strength of the human system—advertising is the remedy for driving out the false statements—the disease germs that tear down the issues that build confidence and success in the business system.

Therefore, buy the advertised products, because, advertising develops the spirit of truth, the spirit of efficiency and the spirit of co-operation.